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EPOCH-MAKING BOOKS IN BRITISH SURGERY.

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III.

A PROVED PRACTISE FOR ALL YOUNG CHIRURGIANS BY WILLIAM CLOWES MAISTER IN CHIRURGERY.

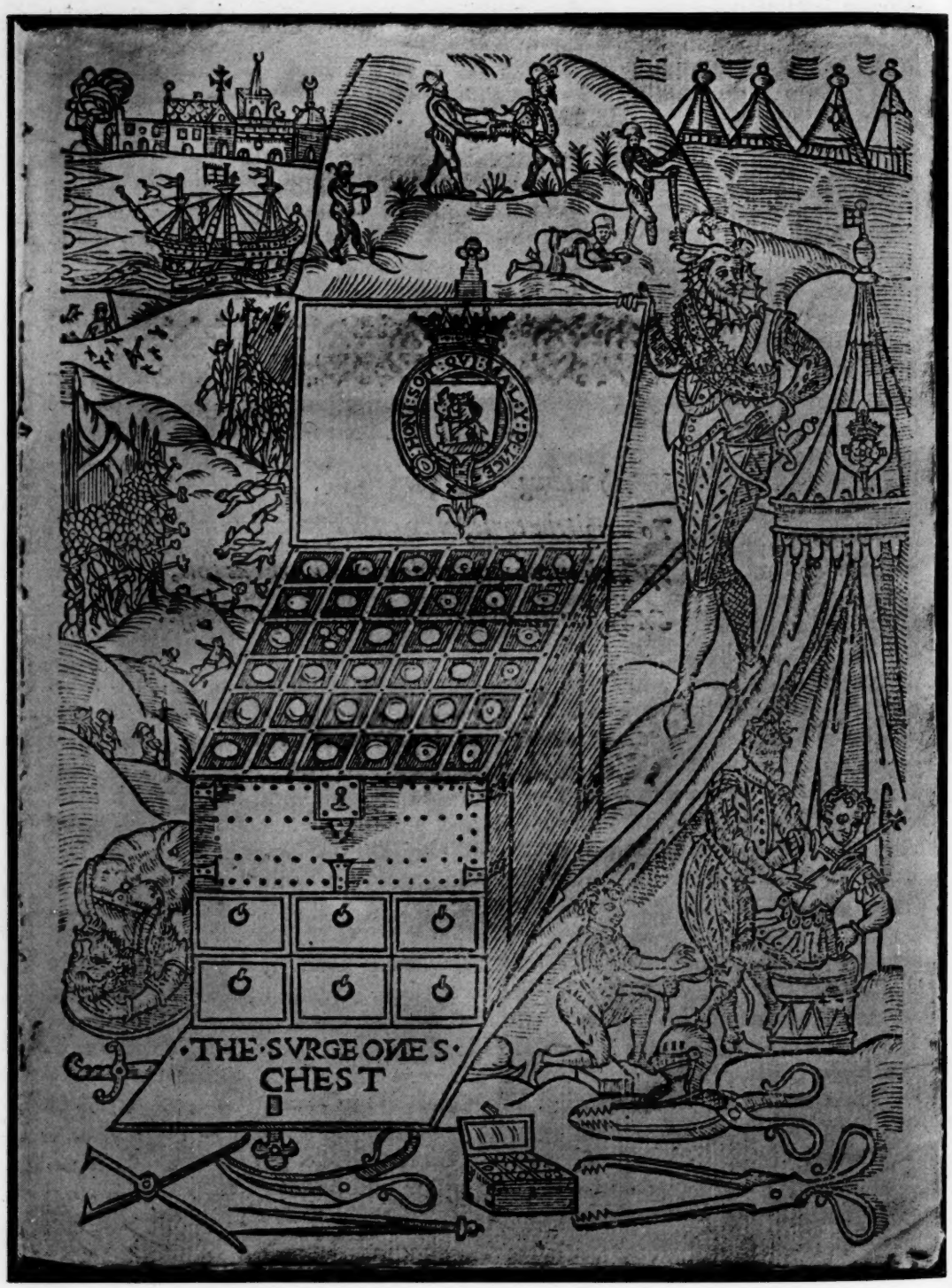
WILLIAM CLOWES the elder, for he had a son who was Serjeant Surgeon to King Charles I, was one of the most prolific surgical writers of his day. He was on good terms with his fellow-surgeons because he was honest in all his dealings, but he hated and was hated by the numerous quacks and unlicensed practitioners who abounded in London in the middle of the sixteenth century, and he made common cause with Gale, Hall, and Read to expose their misdeeds and to raise surgery to the dignity of a profession. The first act of the United Barber-Surgeons Company was to improve the surgical education of their apprentices and members. Examinations were instituted, Gale and Clowes made the examinations a reality and tried to improve the standard by writing treatises which correspond to our modern text-books. Both wrote in English, but the method adopted by Clowes was wholly different from that used by Gale. Clowes told in detail the particulars of cases which he had himself seen, and then set out the treatment he had adopted. He was a good surgeon, trained in the wars like Gale, but he had his limitations, at any rate according to modern views. He was too fond of ointments and plasters, and was especially proud of an oil of whelps (Oleum catulorum) which he had invented, though he does not explain why puppy dogs' fat was better than that of lard or suet. "The Proved Practice" was published in 1588, and it may therefore be looked upon as the third text-book of surgery published in English of which we have at present any certain knowledge—Arderne's works being the first; Gale's being the second. The treatise deals chiefly with gunshot wounds and similar injuries, but much incidental matter is introduced, and it is well worth reading for a picture of life in the times when it was written. Chapter 8 gives an account of the amputation of a "mortified and corrupt leg or arm" in the following words:—

"If it so fall out, or happen, that a leg is to be cut off beneath the knee,

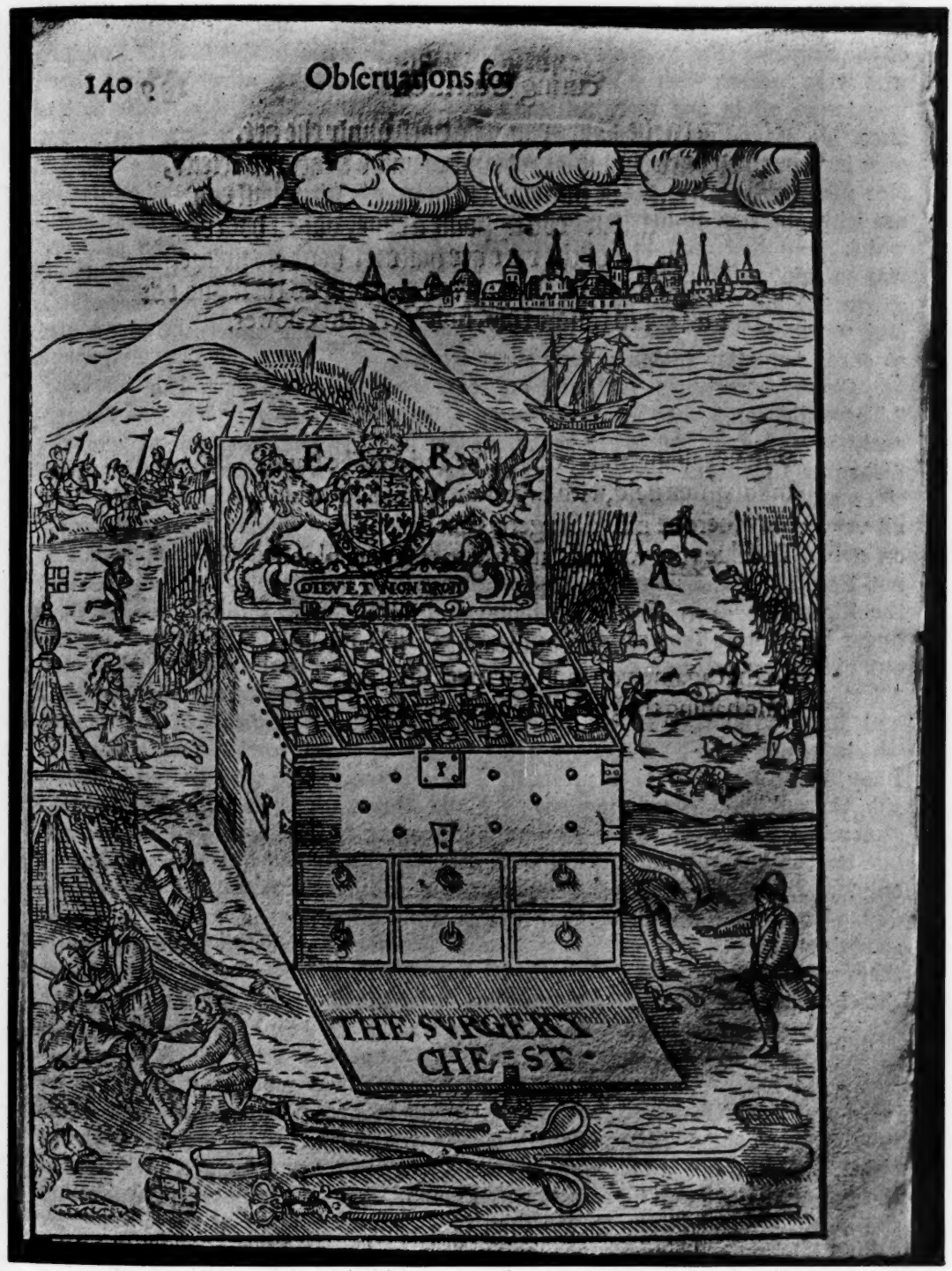
let it be distant from the joint four inches, and three inches above the knee; and so likewise in the arm as occasion is offered. These things being observed and noted, then through the assistance of Almighty God, you shall luckily establish this work by your good industry and diligence. But you must be very circumspect and careful of all things which concern the methodical perfection of this work, that is, you shall have a great regard to the state of his body as also for evacuation and dieting. And after his body is prepared and purged, then the same morning you do attempt to cut off the member, be it leg or arm, let him have two hours before some good comfortable caudle or other broth, according unto the discretion of the learned Physician or Chirurgion only to corroborate and strengthen his stomach. And in anywise omit not but that he have ministered unto him some good exhortation by the Minister or Preacher. And you shall advertise the friends of the patient that the work you go about is great and not without danger of death for that many accidents or syntomies [*perils*, says Arderne's commentator two hundred years earlier using the same word] do run and flock together unto such great wounds, which desperate evils in such causes will many times admit no cure. All which being considered, then ordain the night before some good defensive and let it be applied two or three times about the member.

"All which being well considered you shall have in readiness a good strong form and a steady, and set the patient at the very end of it; then shall there bestride the form behind him a man that is able to hold him fast by both his arms, which done, if the leg be to be taken off beneath the knee, let there be also another strong man appointed to bestride the leg that is to be taken off and he must hold fast the member above the place where the incision is to be made, very steadily without shaking, and he that doth so hold should have a large hand and a good grip, whose hand may the better stay the bleeding; but in some bodies it will not be amiss to admit bleeding, specially in such bodies as are of hot complexions and do abound in blood. And I have known through the skilfulness of the holder not much above four ounces of blood lost at a time. But in weak bodies it may not be suffered to lose much blood, for blood is said to be the treasure of life, for which cause a good holder is not to be spared. In like manner there must be another skilful man that hath good experience and knowledge to hold the leg below, for the member must not be held too high for staying and choking of the saw, neither must he hold down his hand too low for fear of fracturing the bones in the time it is a sawing off, and he that doth cut off the member must be sure to have a sharp saw, a very good catlin and an incision knife, and then boldly with a steady and quick hand cut the flesh round about to the bones without staying, being sure that the Periosteum or Panicle that covereth the bones be also incised & cut with the nerve that runneth between the two bones of the leg which shall be done with your incision knife. All this being orderly performed, then set your saw as near the sound flesh as easily you may not touching it, and with a light hand speedily saw it off. Then take of (a restrictive) powder as much as will serve your turn and mix with the said powder Pilorum leporis torrefact. & ovorum albumin ana quantum sufficet and let the Hare hairs, I say, be cut as fine as possible may be, so much as will bring it all to a reasonable thickness, and when the

powder is thus prepared, before you cut off the member, let there be in like manner made for the purpose three or four small bolsters or buttons fashioned in the top or upper part like a Dove's egg or as a sugar-loaf button flat in the bottom to the compass of a French Crown, and round upwards as aforesaid and these you shall make of fine Tow according to art wrought up in water and vinegar, whereupon you shall supply some part of the restrictive. And when the holder of the member above doth partly release the fast holding of his hand by little and little by which means you may the better perceive & see the mouths of the veins that are incised and cut, you shall place the round ends of these three or four small buttons and upon them presently, without tarrying, place a round thick bed of tow made up in water and vinegar so that it be fit, as near as you can guess it, to the compass of the stump or member that is taken off and thereon spread of the restrictive and upon that you shall lay another broader bed of tow made up as aforesaid, so large that it may compass the member over . . . and you shall tie on the large bed of tow, being cut first with a pair of Scissors in four parts thereof, one cut right over against another, an inch long and somewhat more, that the said bed may be bound to with the more ease. And you shall tie the large bed to, as I said, with a ligature, which they call a chokeband, doubled two or three times, being flat and fully an inch broad and a yard long, and you shall place upon these a double large bed of soft linen cloth and then with a strong roller of four inches broad and three or four yards long let it be artificially rolled and where as the blood beginneth to shew through all, in that place you shall specially lay a good compressor or thick bolster made of tow wrought up in water and vinegar the thickness almost of a man's hand and thin towards the edges and in compass of a Philip's dollar more or less, as you suppose the greatness of the flux to be, and couch them close to in as many places as the blood doth show itself and thus, with three or four rollers and as many soft linen beds some single and some double with sufficient number of bolsters, some great and some small, you shall artificially stay the flux of blood; which order and way did yet never fail me, nor any other that have used the same according unto the order here prescribed. Some also do use to draw over the great bed of tow a wet Ox bladder and pulleth it close up over the same, the which they tie fast to with the aforesaid ligature or chokeband. All which being orderly done then you shall easily as possible may be, carry the patient to his bed, having a pillow made ready to rest the member on. Thus let him lie with as much quietness as may be, keeping a convenient diet; then the third or fourth day you shall have in readiness stupes of white wine with a recent roller, &c." The parts may be burnt with a bright cauterizing iron which, says Clowes, " is most excellent but that it is offensive to the eye and bringeth the patient to great sorrow and dread of the burning and smart." Master Gale's powder may be used, " which powder of his was a worthy invention and better pleased the patients than the burning irons which were, I say, very offensive unto the eye and yet the powder wrought with extreme pain and made a very great eschar & by that means the bones afterwards hath been cut off new again, as I have seen many times within the Hospital of St. Bartholomew's and so did make a very long work or ever they were cured." He invented, therefore,



THE SURGEON'S CHEST FROM THE 1588 EDITION OF CLOWES' SURGERY.



THE SURGEON'S CHEST FROM THE 1596 EDITION OF CLOWES' SURGERY.

a powder which had not these disadvantages, " the which I did put first in practice in the hospital of St. Bartholomew's, as it is well known unto some of the Surgions that then served there, and yet live within this City of London, who were present with me when I first put it in practice, at which time there was taken off in one morning seven legs and arms and so, by God's assistance, we stayed all their fluxes of blood without any pain unto them but only in the compression and close rolling and tenderness of the wound excepted. Not many days after the worshipful Maisters of the said Hospital requested me with the rest of the Surgians to go to Highgate to take off a maid's leg, which they had seen in the visitation of those poor houses. The said leg was so grievously corrupted that we were driven upon necessity to cut it off above the knee, which we did perform by this order here above prescribed, and we stayed the flux and lost not much above four ounces of blood and so cured her after within a very short time."

Clowes sometimes ventured on more serious operations. For instance, " There did come unto me to be cured a Gunner of a ship which was dangerously wounded in the lower region of his belly so that a great part of the Zirbus or Omentum did come out of the wound and also some of the intestines proffered themselves to come forth likewise; but the patient did keep all very close and well till he came unto me. Then I caused him to lie down on a bed upon his back and, after search made, I found the guts safe and not touched of the weapon; then with a strong doubled thread I did tie fast the Zirbus, as close unto the wound as possibly well I might, and then a finger breadth or thereabouts I did cut off that part of the Zirb that hanged out of the wound, and so I cauterised it with a hot iron almost to the knot. All this being done I put again into the body that part of the Zirb which I had fast tied and I left the piece of the thread hanging out of the wound, which within four or five days after nature did cast forth. The thread, as I say, being fast tied, then presently I did take a needle with a double strong silk thread well waxed, wherewith I did thrust through both Mirach [the abdominal wall] and Siphac [the peritoneum] on the right side of the wound, but on the left side of the wound I did put the needle but through Mirach only. . . . Thus with good bolstering and rolling he rested till the second day. Ye shall understand that immediately after he did complain of the grudging of an Ague and being therewith somewhat distempered, presently there was opened a vein and forthwith a gentle mollifying Clyster also. Then, shortly after his bleeding and purging, he mended again and by this means his fever was prevented. Thus in foreshowing of the evils that happened in this cure you may the easilier shun the dangers in others." Also in 1580 there was one, William Mouch, "a serving man who received a wound in his belly and the Zirb issued out of the wound so broad in compass that it did very easily cover a great square trencher, which was cured likewise with the order and remedies afore rehearsed. Moreover in Anno 1586 a little girl of the age of ten or twelve years was also wounded in the belly with a knife that she carried in her hand, so that the Zirb did come forth of the wound the compass of a man's hand, she being then in the country seven miles from London. I did not use any cauteries unto this girl neither yet unto the serving man. The reason partly was for that neither the patients nor their friends

would willingly hear of the hot irons although it were said to be a safe and sure way. Neither did I find any discommodity for not using them, which girl was afterwards brought to London whom I likewise did cure in a very short time; for the which the name of God be praised."

There is also the interesting "cure of a man which received a notable wound in his head with great fracture of the skull and did moreover fracture the bone of the thigh called Os Femoris, by a fall out of a gallery in the Bear Garden, at that time when the Bear Garden did fall down and did kill and hurt many." Clowes operated immediately, shaved the head, put his finger into the wound, found a fracture, enlarged the wound and could do no more because of the bleeding. He therefore plugged the wound and put on a bandage. Then "I caused them to hang all his chamber round about with coverlets and other hangings and made it very dark and without any light or air but only by a candle because in this case air is very hurtful. Then at the second dressing, after I had opened the wound and taken away all things wherewith the wound was filled for the restraining of the blood I caused two strong men steadfastly to stay his head with their hands; and having stopped his ears with wool then I did set on a trepan and so pierced the skull through both the tables in two places and then with an instrument called a Levatory, I raised up the depressed bone with great care and diligence for fear of procuring further accidents, which being done presently his speech amended. And upon Dura mater I found a good quantity of congealed blood which presently I removed for fear of pain and inflammation. After the blood with speed was taken away there was also very apparent to be seen a certain blackness upon Dura mater for the which cause I did put between Dura mater and the skull a fine piece of Lawn dipped in Melle Rosarum. And there was good flesh brought upon Dura mater and the fractured bones being so loosed and borne up and in the place of these bones Nature supplied and ordained a good and perfect callus. And thus he was shortly after well and perfectly cured and made whole of the said wound of his head."

There is also an excellent account of a stout fellow who received a sword thrust through his sternum, the point of the sword coming out at his back. Clowes told those that were present that he greatly feared there was no way of cure, "and so in truth I refused to dress him supposing that he would die under my hand. Then the wounded man desired me as ever I loved a man that I would dress him and take him in cure; for (said he) my heart is good although my wound be great." Clowes cured him, and five years after he had been made whole "he did come to London partly to see me and to give thanks and did show the place that was wounded both where the sword went in and where it did come forth."

The illustration of "The Surgeon's Chest" is reproduced from the 1588 edition. It appears again in the 1591 edition, but in that of 1596 it has been re-engraved, reversed, and materially altered. The Arms of the Earl of Warwick are replaced by the Royal Arms with E. R. on each side. In place of the Stretcher panel there is a view of London showing Old St. Paul's and a ship sailing on the Thames. The bottles in the Chest have been provided with stoppers, and the smaller chest standing by its side has been removed.

CHOLECYSTOGRAPHY: TOXIC EFFECTS OF THE DYES.

A CLINICAL AND EXPERIMENTAL STUDY.*

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A VERY striking advance in the radio-diagnostic investigation of cholecystic disease was made by Evarts Graham when he introduced sodium tetraiodophenolphthalein for that purpose. This new method has obtained wide popularity and has stimulated a closer interest in the problems of biliary diseases. Most writers on the subject refer to the not infrequent toxic manifestations that have been observed after the administration of the agent. These toxic symptoms may be local or systemic, and have varied widely in form and degree. Common phenomena, in our experience, are varying degrees of upper abdominal pain, nausea, vomiting, and diarrhœa, often attended by a rise of temperature. In those cases showing reaction we have been impressed by the frequency of pain or discomfort in the hepatic region. As far as we are aware, only one fatality has been reported from the administration of the drug, which was given in a dosage of 5·5 grm. (Huddy).[1]

The object of our communication is to record some toxic effects of the drug which have not hitherto been observed, and have, in our opinion, an important practical significance; and also to present our experimental investigations of the drug, especially in so far as they bear relation to our clinical experiences.

The first clinical case was one of acute hæmorrhagic pancreatitis, which followed immediately after an intravenous injection; the second was one of jaundice following administration of the drug; the third case recorded was one in which death occurred in a young jaundiced patient within thirty hours of the oral administration of the sodium salt.

In the experimental study, which was carried out upon cats and rabbits, we have endeavoured to reproduce, as far as possible, conditions obtaining in the human subject. Particular attention was devoted to the following considerations: (1) The action of the drug on the pancreas; (2) The action of the drug upon the liver and the kidney in experimental common-duct obstruction; (3) The mode and rate of excretion of the drug in conditions of biliary obstruction.

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CLINICAL RECORD.

Case 1.—Robust miner, age 40, admitted to hospital on account of dyspepsia of six years' duration.

HISTORY.—The man's symptoms had at first been of a rather mild character and took the form of a sense of tightness or fullness in the epigastrium soon after meals. Fatty foods disagreed with him, and a full meal of any sort resulted in troublesome flatulence. For two years before admission the symptoms had been more distressing, and gnawing pain below the right costal margin was frequently experienced. Only on two occasions had the pain been very severe; it had then assumed a stabbing character and radiated through to the back and to the right shoulder-joint, and was attended by bilious vomiting. He had never been jaundiced, but he had noticed that his complexion had been rather sallow during the last year.

ON ADMISSION.—The man was of average height and weighed about 12½ stones. His appearance was that of good health, although his complexion was rather muddy. Examination of the abdomen revealed the presence of deep tenderness and muscular resistance when firm pressure was exerted in the right subcostal area.

The history and clinical examination were suggestive of gall-stone disease; and as a means of confirming this diagnosis the patient was prepared for cholecystography; 5·5 grm. of freshly prepared sodium tetraiodophenolphthalein in 40 c.c. of distilled water were given intravenously, with the usual precautions, at 8.30 in the evening. A feeling of nausea followed the injection. Three and a half hours after the administration the patient began to complain of severe pain in the upper abdomen and in the loins; he spent a restless, uncomfortable night; and on three occasions he vomited light-brown material.

In the morning the temperature was 100°, and the pulse-rate was 90. Pain was more severe and was continuous. Vomiting of a little dark material was repeated at intervals during the day. The vomit was never bilious in character. The patient had become decidedly ill and was considerably shocked, with a rapid pulse; and on examination the abdomen was found to be acutely tender and rigid in its upper part.

By the following day the man was gravely ill; pain was intense and retching was persistent; the abdomen showed considerable distention; the skin was clammy and the lips were a little blue.

OPERATION.—A tentative diagnosis of acute intestinal obstruction was made and the abdomen was opened. From the peritoneal cavity about three pints of maroon-coloured thick fluid escaped; and scattered spots of fat necrosis were noticed on the greater omentum. The small intestine was distended with gas. The pancreas, though only moderately enlarged, was converted into a hæmorrhagic mass. The gall-bladder was twice the normal size and was very thick-walled; it was packed tightly with small faceted stones. The common bile-duct contained several small calculi. It was not determined if a stone was impacted in the biliary ampulla.

As the man's condition became very critical, his return to bed was hastened, a drainage tube being placed in the region of the pancreas. Death occurred the same day. Permission to make a post-mortem examination was not obtained.

COMMENT.—The weight of the drug administered was 5·5 grm., which was the customary dose employed at the period when the patient was in hospital. It must be recognized that this dosage was in excess of that originally recommended by Evarts Graham.

As this acute abdominal crisis appeared within three and a half hours of the giving of the drug, our suspicions were strong that the drug had been responsible, in some way, for exciting the onset of the crisis, especially as the patient had been in good health immediately before its administration.

Case 2.—Woman, age 50, admitted for pains in her joints and indigestion of three years' standing.

HISTORY.—The patient had noticed that her appetite was failing and that many of the common articles of diet, such as potatoes and thick soups, disagreed with her.

After a heavy meal she had pain in the upper abdomen, accompanied by flatulence which produced a sensation of choking. For nine months she had had occasional attacks of sharp pain in the right hypochondrium soon after food, attended by nausea and headache, and occasional shivering attacks.

On Admission.—The patient was of sallow complexion and of flabby build; weight 10¼ stones. Her temperature was subnormal. Examination of the abdomen showed the presence of slight tenderness on deep pressure below the right costal margin at the outer border of the right rectus.

The patient was made ready for cholecystography as the symptoms suggested that a lesion of the gall-bladder was responsible for her dyspepsia; 3·5 grm. of sodium tetraiodophenolphthalein in 50 c.c. of water were given intravenously at 8.30 in the evening. There was no immediate reaction after the injection. In the early part of the night the patient complained of headache, and shivered once or twice. At 2 a.m. the headache was more severe and she felt very sick. Next day it was noticed that she was slightly jaundiced, this being most evident in the sclera. The temperature had risen to 99°; and pain and increased tenderness were present in the right subcostal region. Jaundice persisted for two days and gradually became less evident.

In the radiograms the gall-bladder was not outlined.

Operation.—The gall-bladder was of normal size; its walls were thickened and it contained two large stones and a small one. One of the large calculi was a pure cholesterol stone and was gripped securely at the neck of the gall-bladder. Bile was absent from the gall-bladder, its place being taken by a small quantity of clear mucoid fluid. There was no stone present in the common bile-duct. The pancreas was enlarged and was extremely tough and fibroid in consistence. Cholecystectomy was performed; recovery was uneventful.

Comment.—The occurrence of jaundice following an injection of sodium tetraiodophenolphthalein has not been noted before. The cause in this case is not clear. Nuthall[2] mentions a case in his experience in which existing jaundice was increased by the exhibition of the drug intravenously.

Case 3.—Unmarried girl, age 20, of strong physique, admitted on account of attacks of abdominal pain and jaundice.

History.—The patient was strong and healthy until three months before coming to hospital. During that time she had had repeated attacks of fairly severe pain in the right upper quadrant of the abdomen and in the right iliac fossa. The attacks of pain seemed to come on after severe exertion, and on an average she had two in a week; she felt quite well in the intervals, and her appetite remained good. On three occasions the attacks of pain were attended by vomiting; and for some time before admission she had been troubled with flatulence after meals. After two of the painful attacks she had been slightly jaundiced, but the jaundice quickly passed away. The attack which culminated in her admission to hospital was attended by deeper jaundice, which had been present for six days before she came under observation.

On Admission.—Except for the moderately deep jaundice the patient looked strong and well. Temperature 99°; pulse-rate 85. The stools were pale and bulky, and the urine was dark from its bile content. On abdominal examination the patient was found to have tenderness over the upper part of the right rectus muscle, and a slight amount of muscular rigidity was present there.

The patient, though young, was thought to be suffering from gall-stones, and preparation was made for cholecystography; 10 capsules, each containing ½ grm. of sodium tetraiodophenolphthalein, were given by the mouth late in the evening, followed by sips of bicarbonate of soda in water. Early the following morning she suddenly became very restless and noisy, and vomited. Incontinence of urine was present for a short time, followed by complete suppression. The temperature and pulse-rate remained normal. In the evening of the same day the patient had a convulsive seizure in which the head and neck became rigid and the teeth

tightly clenched. Unconsciousness followed, and she died early the following morning, about thirty hours after the administration of the sodium salt, and six days after her admission to hospital.

POST-MORTEM EXAMINATION.—The liver was normal in size and was pale in colour, having a distinctly fatty appearance. Gall-stones were not present in any part of the biliary tract. No undissolved capsules of the drug were found in the alimentary canal. The kidneys appeared normal to the naked eye.

Histological Report on Sections of the Liver and Kidney.—Liver : " The appearances are very suggestive of acute yellow atrophy. There seems to have been both cirrhosis and fatty degeneration. The liver is congested, and numerous leucocytes are massed together at the centre of the liver lobules, suggesting a phase of hepatitis, perhaps of portal origin." *Kidney* : " Large hæmorrhagic areas are seen in the kidney, and the tissues show leucocytic infiltration ".

COMMENT.—It was difficult to decide whether this case was primarily one of acute yellow atrophy or of simple catarrhal jaundice. The patient did not appear to be very ill, and there was no contra-indication to the use of the sodium tetraiodophenolphthalein. It seems certain, however, that the administration of the drug accelerated the course of the patient's illness and contributed to its fatal ending.

EXPERIMENTAL INVESTIGATION.

Animals Employed.—The effects of intravenous injections of sodium tetraiodophenolphthalein were investigated in both cats and rabbits under various conditions. Cats were selected for the study of the action of the drug upon the pancreas because of the resemblance of their biliary-duct system to that of the human subject. All operations were carried out under ether anæsthesia and with a sterile technique.

Dosage.—A dosage of 0·05 grm. of sodium tetraiodophenolphthalein per kilo. body weight of the animal was employed; when smaller or larger doses were given, reference to that effect is made in the descriptions of individual experiments. The technique of intravenous injection was carried out with the same precautions as in the case of human beings. Some of the experimental animals and their controls were killed with ether, others with hydrocyanic acid.

Chemical Analysis.—This was carried out upon bile, pancreatic juice, and urine. The method was based upon the estimation of the total iodine content of the particular fluid, and was an adaptation of the method recommended by Kendall[3] for another purpose.

THE ACTION OF SODIUM TETRAIODOPHENOLPHTHALEIN ON THE PANCREAS.

The Excretion of the Drug by the Pancreas.—Pancreatic juice was collected from the cat by a cannula inserted through the duodenum into the pancreatic duct.

In the cases in which the bile-duct was left patent, none of the drug was detected in the pancreatic juice after an intravenous injection.

In cats in which the common bile-duct was ligatured, and which were given an intravenous injection of the agent, it was found that the pancreatic juice invariably contained small but appreciable amounts of the drug. In

conditions of biliary obstruction the drug was detected at intervals ranging from six to forty-eight hours after intravenous injection. In one sample of pancreatic juice, taken from a cat twenty-four hours after ligature of the common bile-duct and injection of the agent, 0·00011 grm. of sodium salt was found in 1 c.c. of pancreatic juice.

Gross Effects of the Drug on the Pancreas.—

EXPERIMENT 1.—Cat D.C. 1. Weight 3·5 kilo. Inferior pancreatico-duodenal artery perfused with 0·1 grm. of sodium salt in 10 c.c. of physiological saline.

Result.—Death in 10 hours. Diffuse hæmorrhagic extravasation into head and body of pancreas. Widespread œdema of peritoneum and retroperitoneal tissues. Scattered patches of fat necrosis in peritoneum near the pancreas.

EXPERIMENT 2.—Cat D.C. 2. Weight 4·5 kilo. Cannula passed along pancreatic duct via the duodenal papilla; 0·05 grm. of sodium salt in 1 c.c. of distilled water injected very slowly into the pancreatic duct.

Result.—Death in 6½ hours. Hæmorrhagic extravasation into head of pancreas, also at one place in body of organ. Fat necrosis seen in organ itself and in peritoneum at root of the transverse mesocolon.

The above two experiments were undertaken to obtain a measure of the gross action of the drug when it is brought into direct contact with the pancreatic tissues. The results do no more than illustrate the toxic character of the drug when administered in large doses.

The Action of the Drug on the Pancreas in Normal and Abnormal Conditions.—(1) In the rabbit and cat no changes, naked-eye or microscopic, were detected in the pancreas after a single intravenous injection of the sodium salt. (2) In rabbits in which the common bile-duct was ligated before the intravenous injection of the drug, the changes were very striking. Nine such experiments were performed; in four instances the rabbits died within thirty-six hours from acute hæmorrhagic pancreatitis with fat necrosis, local or disseminated. In two instances there was marked swelling and pallor of the gland, with a few patches of fat necrosis on its surface. In the remaining three rabbits no changes were observed.

EXPERIMENT.—Large brown rabbit D.P. 5. Weight 3·2 kilo. Intravenous injection of sodium tetraiodophenolphthalein five hours after ligature of the common bile-duct. Dosage 0·15 grm.

Result.—Died about 14 hours later. Abdominal wall very œdematous in region of operation wound. Peritoneal cavity contained 2 oz. of sero-sanguineous fluid. There was extensive hæmorrhagic extravasation into the head and part of the body of the pancreas. Fat necrosis was present on the surface of the pancreas and in the adjacent peritoneum. A subcapsular hæmorrhage was present in the left kidney.

The above striking effects were not observed in the cat under similar conditions. In this animal the pancreas became a little enlarged; microscopic sections of the organ demonstrated a marked degree of vascular engorgement, but no degenerative changes in its glandular structure.

The Effect of Bile containing Sodium Tetraiodophenolphthalein on the Pancreas.—Cats were used for these experiments.

EXPERIMENTAL TECHNIQUE.—The duodenum was opened opposite the biliary ampulla, and a fine glass cannula was passed into the main pancreatic duct for a distance of half an inch: 0·5 c.c. of bile, withdrawn from the

animal's gall-bladder, was injected by a syringe into the pancreatic-duct system. Very gentle pressure was employed, and twenty to thirty minutes were taken to complete the full injection. When the animal had previously received an injection of sodium tetraiodophenolphthalein, the concentration of the drug in the gall-bladder was estimated chemically in each instance.

The experiment was carried out on five animals. In each case a control experiment was performed with bile uncharged with the sodium salt. In three of the experiments and their controls the animal had been fasting for eighteen hours ; in the remaining animals digestion was in progress at the time of operation.

EXPERIMENT.—Female cat, D.P. 5. Weight 2 kilo. Injection of 0·5 c.c. of animal's own bile taken from gall-bladder five and a half hours after an intravenous injection of 0·1 grm. of sodium tetraiodophenolphthalein (0·4 grm. of bile contained 0·0077 grm. of the salt). The pancreas assumed a mottled-brown appearance, due to the bile staining. Within five minutes of the perfusion of bile the overlying peritoneum had become very glazed and œdematous. Within fifteen minutes of the injection the pancreas had become very congested, especially in the region of the head, and a blotchy brick-red discoloration made its appearance. After thirty minutes a few scattered capillary hæmorrhages were noticed in the head of the organ. At the conclusion of the operation the peritoneal œdema and the general blotchy suffusion of the pancreas had increased, and the bile staining had faded considerably.

Result.—Death in 36 hours.

Post-mortem Examination.—Pancreas very red and congested throughout and swollen to twice its normal size. Small areas of extravasation of blood present in head and body of organ. No bile staining persisted. Fat necrosis well marked in upper part of greater omentum, and in peritoneum around the pancreas, especially at the root of the mesocolon.

FIG. 246.—*Cat* D.P. 5. Microscopic section of pancreas of cat which died of acute pancreatitis following injection of 0·5 c.c. of bile containing sodium tetraiodophenolphthalein. Note disorganization and necrosis of pancreas, with extensive hæmorrhages.

Microscopic Appearance of the Pancreas.—Gross disorganization of structure. In some places there was massive necrosis of pancreatic lobules ; in others only the centre of the lobules showed necrosis. In some parts the pancreas appeared normal. In some areas diffuse extravasation of blood was present, in others merely capillary hæmorrhages. (*Fig.* 246.)

CONTROL.—Female cat. Weight 2·5 kilo. Injection into pancreatic duct of 0·5 c.c. of animal's own bile. Pancreas coloured yellowish-brown by the injection ; twenty to thirty minutes after the injection the pancreas was a little swollen and peritoneal œdema became evident. The pancreatic swelling and œdema were never so marked as in the above experiment, nor was the mottled red appearance reproduced.

Result.—Cat made a quick recovery, took food willingly, and rapidly resumed its normal activities. Killed at the end of two weeks.

Post-mortem Examination.—Pancreas a little swollen and of a pale yellowish-white colour. No fat necrosis present in the pancreas or at a distance.

Microscopic Appearance of Pancreas.—Slight perilobular œdema was shown. The finer blood-vessels and capillaries were engorged with blood. There were no hæmorrhages. The finer pancreatic ducts were normal in appearance.

The acini of the gland stood out clearly and the component cells were in most places normal; here and there masses of acini showed cloudy swelling and slight hyaline degeneration. In no part was there any cellular necrosis.

In all of the five cats in which the pancreatic ducts were perfused with bile containing sodium tetraiodophenolphthalein, death occurred within two to five days. In each case death was due to acute pancreatitis with fat necrosis. The five animals in which bile alone was employed recovered and were little affected by the operation. No differences were noticed, in the effects on the pancreas, between the animals which were fasting at the time of operation and those which were digesting.

As a further control of the supposed toxic effect of the drug on the pancreas the following experiments were carried out :—

EXPERIMENT.—Cat D.P. 11. Weight 2·2 kilo. Perfusion of pancreatic ducts with 0·5 c.c. of normal saline containing an amount of sodium tetraiodophenolphthalein equal to that present in 0·5 c.c. of bile from the gall-bladder after an intravenous injection of the agent. In this cat 0·008 grm. was employed.

Result.—Animal remained very listless and inactive for a few days after operation and took no food; became very thin and weak. Killed on sixth day after operation.

Post-mortem Examination.—Pancreas was about twice its normal size and had a lardy milky-white appearance. The individual lobules of the organ stood out in abnormal prominence and there was a general œdema of the whole organ. Patches of fat necrosis were present in the pancreas itself, in the gastric peritoneum, and around the portal vein.

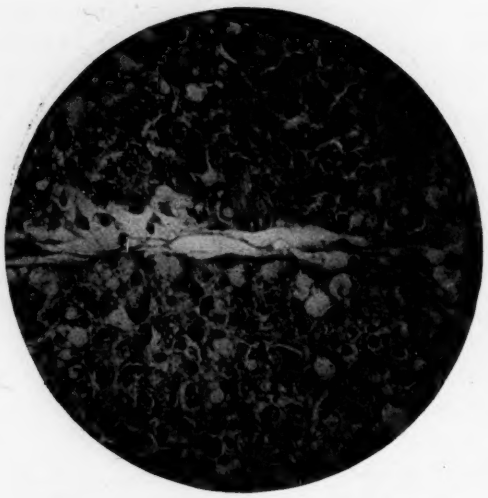

FIG. 247.—*Cat* D.P. 11. Microscopic section of pancreas of cat after injection of 0·008 grm. sodium tetraiodophenolphthalein in 0·5 c.c. of normal saline into the pancreatic duct. Note cell degeneration and loss of normal acinous arrangement.

Histological Appearance of the Pancreas.—There was an almost total loss of the normal acinous structure of the gland lobules. The lobules themselves had the appearance of being fused together. There was a general desquamation of the acinous epithelium, and also of the epithelial lining of the pancreatic ducts. In places whole blocks of acini were undergoing necrosis. Only in a few places were perfectly normal acini seen, and these were mostly at the periphery of the organ. There were no capillary hæmorrhages. (*Fig.* 247.)

EXPERIMENT.—Cat D.P. 12. Weight 3·2 kilo. Perfusion of pancreatic duct with 0·5 c.c. normal saline. Animal was allowed to recover, and was killed after a week.

Result.—Pancreas looked normal in colour. There was no swelling of the organ and no œdema. No fat necrosis.

Histological Appearance of the Pancreas.—No departure from the normal was detected.

THE ACTION OF SODIUM TETRAIODOPHENOLPHTHALEIN UPON THE LIVER AND KIDNEY IN EXPERIMENTAL COMMON BILE-DUCT OBSTRUCTION.

Gross Effect of the Drug on the Liver.—

EXPERIMENT.—Cat L.W. 3. Weight 3·2 kilo. Left hepatic artery perfused with 0·1 grm. of sodium salt in 5 c.c. of physiological saline.

Result.—Death after 1½ hours. Liver was like yellow ochre in colour, especially the left lobe. Microscopically, the left lobe of the liver showed complete disintegration of its lobular structure: extensive cellular necrosis was present throughout. Similar changes, though less marked, were present in the right lobe.

Effect of the Agent upon the Liver in Experimental Common Bile-duct Obstruction.—As compared with normal animals and control animals, it was found that the drug was badly tolerated in animals in which the common bile-duct had been ligatured previously, collapse and sudden death occurring more frequently after the intravenous injections. Animals in which the common bile-duct was ligated, and which had received three injections of the drug over a period of seven days, showed more advanced degenerative changes in the liver than was the case in normal animals receiving the same dosage.

COMMENT.—These experiments illustrated that the drug had a greater toxicity upon the liver in the presence of obstructive jaundice.

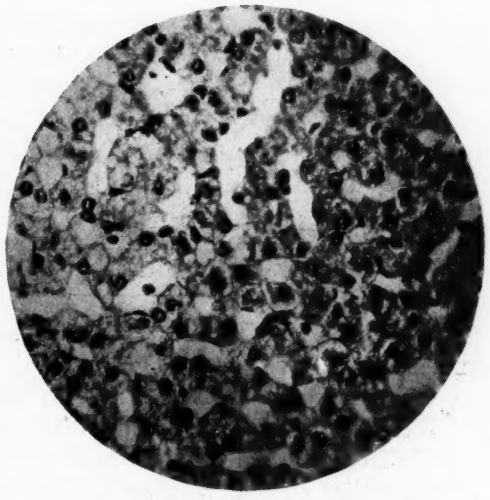

FIG. 248.—Microscopic section of liver of cat, killed forty-eight hours after ligature of common bile-duct and injection of sodium tetraiodophenolphthalein (0·05 grm. per kilo). Note vacuolation and granular degeneration of the cytoplasm, and that the nuclei are unaffected.

Histological Changes in the Liver of Animals with Common Bile-duct Obstruction after a Single Intravenous Administration of the Drug.—The most constant change was in the cytoplasm of the liver cells, which became œdematous within forty-eight hours, and showed definite granular degeneration with vacuolation; the normal nuclear staining was preserved, and the structure of the liver lobule unaltered. The cellular changes were general in their distribution throughout the organ. (*Fig.* 248.)

The Effect of the Drug on the Kidney in Biliary Obstruction.—The changes observed in the kidney were never more than slight when diagnostic doses were employed. The only constant change seen in microscopic sections was a general vascular engorgement of the whole organ. In a number of cases the glomeruli were swollen and the epithelium of the convoluted tubules showed an early stage of cloudy swelling; the cells of the collecting tubules were unaffected.

THE MODE AND RATE OF ELIMINATION OF SODIUM TETRAIODOPHENOLPHTHALEIN WHEN THE COMMON BILE-DUCT IS OBSTRUCTED.

The drug was eliminated almost entirely by the kidneys when the biliary route of excretion was unavailable. The rate of excretion was very slow. The agent was detected in the urine as long as eighteen days after an intravenous injection; 5 to 10 per cent of the salt was excreted by the kidneys in the first twenty-four hours after the intravenous injection. The following table shows the rate of excretion over a period of six days in a cat weighing 3·8 kilo. and in which the common bile-duct was ligated immediately before an intravenous injection of 0·19 grm. of sodium tetraiodophenolphthalein.

Quantity of Urine Collected by Catheter		Weight of Sodium Salt in each Sample of Urine
35 c.c.	In first 29 hours	0·0042 grm.
35 ,,		0·00525 ,,
22 ,,		0·00242 ,,
18 ,,		0·00216 ,,
20 ,,		0·0018 ,,
37 ,,		0·00444 ,,
14 ,,		0·00896 ,,
8 ,,		0·00044 ,,
25 ,,		0·0025 ,,
40 ,,		0·0036 ,,
Total 254 c.c.		0·03577 grm.

Quantity of bile obtained post mortem from gall-bladder and ducts in same animal = 15 c.c.

Quantity of sodium salt in this volume of bile = 0·135 grm.

Hence 0·1708 grm. of the 0·19 grm. administered was accounted for in the bile from the gall-bladder and ducts and in the urine which was collected.

Quantity of the sodium salt excreted in six days = 18·83 per cent, of which 5 per cent was excreted in the first twenty-four hours.

DISCUSSION AND CONCLUSIONS.

From our clinical experiences and experimental findings it appears that the use of sodium tetraiodophenolphthalein in diagnostic doses is not free from risk in certain circumstances.

In the absence of other contributory factors, normal bile containing sodium tetraiodophenolphthalein introduced experimentally into the pancreatic ducts is sufficient to produce acute pancreatitis. It may thus be inferred that in cases of cholelithiasis in which stones are present in the common bile-duct, and the conditions are otherwise favourable for the retrojection of bile into the pancreas, the danger of acute pancreatitis occurring will be much greater if the regurgitated bile contains the phenolphthalein salt.

In obstructive jaundice the normal route of elimination of the drug is unavailable, and small quantities are excreted in the pancreatic juice. In animals with experimental biliary obstruction, especially in rabbits, it was

found that pathological changes occurred in the pancreas, ranging from simple vascular congestion to hæmorrhagic pancreatitis. The conclusion to be drawn from this is that there is risk of damage to the pancreas by the administration of the agent to jaundiced patients who have chronic obstructive lesions of the biliary passages.

Case 3 in the clinical record illustrates the toxic effect of the drug in jaundice. The pathological changes which were experimentally produced in the liver lend strong support to the opinion that the toxicity of the drug on this organ is greater when biliary obstruction is present. In this case, however, the liver was probably the site of a pathological lesion, and it is reasonable to believe that the drug exerts a greater toxicity on an organ whose function is already impaired.

Although the agent is eliminated by the kidney in biliary obstruction, no ill effects apparently ensue in the normal kidney; nor, indeed, is this to be expected, as the rate of excretion is slow.

In justice to this valuable diagnostic method and to its originator it should be emphasized that, in two of the cases we have reported, larger doses than are now known to be safe were employed. The recorded cases were selected from many hundreds in which the drug had been exhibited without ill effect.

SUMMARY.

1. The toxic manifestations which appeared after the administration of sodium tetraiodophenolphthalein in three cases are recorded. In the two fatal cases larger doses than those recommended by Graham were employed.

2. The injurious effects which the agent may in some circumstances produce on the pancreas are detailed.

3. The dangers of the use of the drug in cases of obstructive jaundice are indicated.

4. In obstructive jaundice the drug is eliminated, almost entirely, in the urine. An estimation of the rate of excretion has been given.

5. The results of an investigation into the action of the drug on the normal kidney are described.

We are indebted to Mr. A. A. Scot Skirving for his permission to publish *Cases* 1 and 2, and to Mr. J. N. J. Hartley for *Case* 3. We desire to express our thanks to Professor D. P. D. Wilkie for his helpful direction and criticism in the conduct of the experimental work. For his advice and suggestions in connection with the chemical investigations we are obliged to Professor G. Barger.

We owe thanks also to the Trustees of the Moray Endowment Fund and the Medical Research Council for grants which enabled us to defray the expenses of the research work.

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RUPTURE OF THE URETHRA.

By HAMILTON BAILEY,

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"Rupture of the urethra is one of the most serious of accidents, and unless your skill can prevent the development of a stricture, you are presiding at the opening of a life-long tragedy." (*Rutherford Morison.*)

"Every rupture of the urethra, even the slightest, is a potential stricture." (*Boeckel.*)

RUPTURE OF THE BULBOUS URETHRA.

It is doubtful if there is a traumatic lesion in the whole range of surgery where the nature of the violence is as stereotyped as in rupture of the bulb of the urethra. Almost without exception there is the history of a fall astride

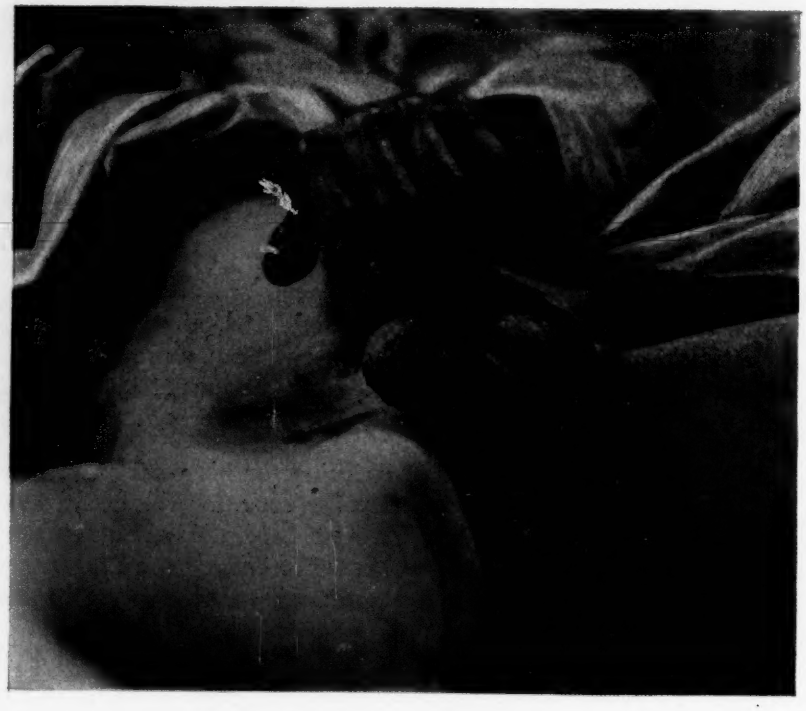

Fig. 249.—Complete rupture of the bulb of the urethra. (Blood is trickling from the meatus.) The patient had fallen astride a few hours before the photograph was taken.

a projecting object (*Fig.* 249). The exceptional case is where the patient has received a 'kick in the crutch'. In studying the records of twenty consecutive cases of rupture of the urethra admitted to the Liverpool Royal Infirmary

during the past decade, I noticed that in only one instance was the patient a mariner. In days gone by sailors working aloft were particularly liable to this accident, but with the passing of the windjammer this relatively high incidence has been much reduced. To-day rupture of the urethra is principally an accident of industrial life. A review of any collected series[1, 2, 3, 4] of cases of this particular accident will reveal that a considerable percentage are boys. This percentage, though noteworthy, is not quite so high as is sometimes stated.[5] On an average, rather more than one quarter are under eighteen years of age.

Two outstanding features of a ruptured urethra are hæmorrhage via the meatus and the presence of a perineal hæmatoma. Legueu[6] states that the gravest ruptures have the largest hæmatomas. Within the past year three cases have come under my observation in which the perineal hæmatoma

FIG. 250.—Rupture of the bulb of the corpus spongiosum with extravasation of the blood into the scrotum. In spite of the magnitude of the hæmatoma, the urethral mucosa was hardly damaged.

was very extensive, and in one of these (*Fig.* 250) the extravasation of blood was considerable. Yet on further examination it was found that the mucosa was comparatively intact. It is quite clear that the bulb of the corpus spongiosum may be severely damaged, and its ensheathing envelope broken, whilst the mucous membrane remains untouched.

Hæmorrhage via the meatus is certainly good evidence that the mucosa is involved, but its profusion is no guide to the severity of the rupture. Some time ago I saw a patient who, three days previously, had stepped on to the lid of a pavement coal-hole which was not securely in place, with the result that one leg went down into the cellar whilst the perineum bore the brunt of the fall. For three days severe urethral hæmorrhage had continued, and the patient was profoundly anæmic, yet an exploring catheter readily slipped into the bladder.

Retention of urine is usual after these urethral injuries. It is due to a reflex spasm of the compressor urethræ. Proof of this is afforded by the fact that the bladder is sometimes emptied as soon as the patient is fully anæsthetized (Heitz-Boyer[7]). This spasm of the compressor prevents extravasation for many hours. Extravasation of urine due to a ruptured bulbous urethra is now rarely seen, and usually signifies that the case has been neglected. On the other hand, when the rupture is *above* the compressor, extravasation into the cellular tissues of the pelvis occurs early (*Fig.* 251).

The triad of signs of a ruptured bulbous urethra are urethral hæmorrhage, a perineal hæmatoma, and retention of urine—to which may be added a fourth, pain. These, however, afford but little clue to the severity of the mucosal tear. There is as yet no method by which the extent of the lesion can be inspected conveniently. Aero-urethroscopy in the presence of hæmorrhage is absolutely contra-indicated, because of the danger of air embolus. The posterior urethroscope in which water dilatation is used is free from this danger, but this instrument is seldom at hand in an emergency.

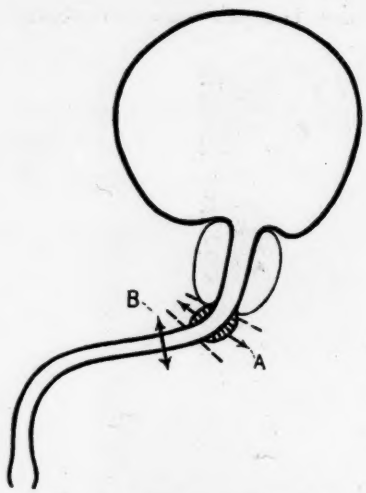

FIG. 251.—Extravasation into the cave of Retzius occurs early when the intrapelvic urethra is ruptured. In rupture of the bulb the reflex spasm of the compressor prevents extravasation for many hours. A, Extravasation early; B, Extravasation late.

The usual method of differentiating between a complete and an incomplete lesion is by sounding, and for this purpose there is no better instrument than the coudé catheter, the nose of which can be readily made to follow the roof of the urethra. Instrumentation should only be carried out after the anterior urethra has been thoroughly washed out with a mild antiseptic solution. The almost universal practice of casualty officers and others of attempting to pass a catheter with only ordinary precautions, and the mild infection of the lacerated tissues which thereby ensues, probably account for a large number of traumatic strictures. The sounding should be carried out in the operating theatre, where asepsis can be assured and operative measures can be undertaken immediately in necessary cases.

If urgent relief of retention of urine is needed before these facilities are at hand, such as may be the case in remote districts or at sea, catheterization is still contra-indicated. The bladder should be emptied by suprapubic aspiration. In cases of ruptured urethra or suspected rupture, promiscuous catheterization must be stopped. The catheter *can* be withheld, even in the direst emergency under the most extenuating circumstances. A case of what proved eventually to be complete rupture of the urethra occurred on board ship four days out from Havre. Catheterization was not attempted, retention being relieved by repeated suprapubic punctures until the ship reached port, when the patient was transferred to hospital. Extravasation did not occur. (Marion.[8])

INCOMPLETE RUPTURE.

Incomplete rupture of the urethra is too often looked upon as a trivial accident, especially by the patient, who can only with difficulty be persuaded to attend for regular inspection after he has left hospital. For many years French surgeons,[1, 2, 7, 9] who have devoted much thought to this subject, have insisted that the tied-in catheter, and the concomitant infection, is the most potent cause of stricture formation. In this country the tied-in catheter still appears to be much in vogue for the treatment of incomplete rupture. I have seen it in use at every hospital in which I have worked.

Reginald Harrison,[10] as long ago as 1880, advocated perineal section as the safest plan of diminishing stricture formation in these cases. It would be sound teaching to insist that all cases of incomplete rupture in which bleeding from the meatus has occurred require perineal drainage. A catheter brought out in the perineum behind the point of the rupture,[11] and retained for forty-eight hours, is not open to the foregoing objection, and can only do good by keeping the urine away from the damaged mucous membrane.

W. J., age 29, complained of increasing dysuria. Four months previously he had fallen astride, and hæmorrhage had occurred from the meatus. He had been treated by an indwelling catheter, and was detained in hospital for a few days. Urethroscopy revealed a dense bulb stricture, and only a whip guide could be passed. Internal urethrotomy and subsequent dilatation proved most satisfactory.

Examples of severe stenosis following an apparently trivial urethral injury are common.

COMPLETE RUPTURE.

The difficulty which is sometimes encountered in locating the posterior end of the divided urethra within bruised, blood-stained tissues, is a byword. Duplay spent one and a half hours, and Desguin[12] two and a half hours, looking for this elusive structure, and many times a fruitless search has been abandoned. In order to overcome this difficulty numerous methods have been devised, some of which are most ingenious.

Methods of Finding the Posterior End of the Divided Urethra.

1. "Go over the whole area with a director, exploring each orifice, each depression, and each little reddish nodule." (Lejars.[13])
2. The urethra appears white when sponged clean of blood. (Warren.[14])
3. The vesical end of the urethra will be found further forwards than you are inclined to think. (Current London teaching.)
4. The urethra may be identified by the persistent bleeding of a vessel in its walls. (Thomson and Miles.[15])
5. The assistant should compress the bladder above the symphysis, and the operator watch for the spot where the urine issues in the perineal wound. (De Vlaccos,[16] Cowles,[17] et al.)
6. When the bladder is empty the assistant should compress the vesiculæ with a finger in the rectum.

7. The gloved finger should be inserted into the rectum, and when placed on the apex of the prostate will indicate the exact position of the membranous urethra; by probing at this spot the opening will be found. (Burghard.[18])

8. The completely severed posterior end of the membranous urethra may be discovered by palpation. The urethra will be felt in the perineal floor as a depression with a salient edge. (Mignon.[19])

9. The patient should be given potassium iodide by mouth before operation, and the various likely spots in the perineal wound are touched with lead acetate. The bright coloration of the lead iodide assists in marking the urethra.[20]

10. By palpation with the volar surface of the finger, the urethra can be rolled under the finger as a somewhat flattened cylindrical mass. The mass is fixed by the fingers against the bone and boldly incised longitudinally. (Van Hook.[20])

11. Excise *en masse* the bruised superficial tissues with curved scissors. The aspect of the region changes completely. We see, as clearly as in a dissection, the star-shaped orifice of the posterior end of the urethra under the pubic arch. (Heitz-Boyer.[21])

12. Identify the transversus perinei muscle, and make a transverse incision behind it. This will open the urethra, and a catheter may then be passed through this opening to the point of the rupture. (Legueu.[22])

13. Suprapubic cystotomy and retrograde catheterization.

It is evident that the length of time taken to find the proximal end of the urethra is likely to be directly proportional to the amount of additional laceration of the peri-urethral tissues. Probing, handling, incising, and daubing with chemicals cannot but retard the healing of tissues which have already been grossly insulted; neither can a wound be expected to escape infection when but half an inch distant intrarectal manipulations are in progress.

Retrograde Catheterization is the only method which never fails, and it has long been recognized as a means of dealing with difficult cases. It was first employed by Verguin,[23] of Toulon, in 1757, who, being unable to locate the posterior end of the ruptured urethra, punctured the bladder above the pubis, left the cannula *in situ*, and a few days later passed a catheter through the cannula to the perineal wound.

Until recent years suprapubic cystotomy with retrograde catheterization has been an *ultimum refugium*. Latterly there has been a growing tendency to resort to this excellent method at the first sign of difficulty. Nevertheless, it must be admitted that when resorted to after other methods have failed, the necessary manipulation of the patient from the lithotomy position to the prone and back again to the lithotomy leaves something to be desired, for this change of posture is time-consuming and must endanger asepsis. In no given case is it possible to foretell if difficulty will be experienced in finding the posterior end of the urethra or not. Suprapubic cystotomy and retrograde catheterization circumvents this difficulty; it renders the perineal operation a swift and certain procedure; in addition, by subsequently preventing the passage of urine over the lacerated tissues, it actually

aids the healing of the damaged mucous membrane. Surely the time is long overdue for it to be generally taught that the first step in every operation for complete rupture of the urethra is suprapubic cystotomy.

METHODS OF DEALING WITH THE RUPTURE.

End-to-end Anastomosis.—After Guyon,[24] in 1892, had shown the feasibility of uniting the severed ends of the divided urethra, end-to-end anastomosis became a standard method of treating complete rupture. Undoubtedly this method has given numbers of brilliant results. Through the kindness of Mr. Hugh Lett I was enabled to pass a urethroscope on a patient who had had this operation performed twenty years previously by Mr. Mansell Moullin. No sign of stricture could be seen, and a full-sized bougie readily entered the bladder.

Had the operation not given many excellent results, there is no doubt it would have long since perished. Whilst we must acclaim that perfect individual results have been achieved by this technique, it is also certain that dense unyielding strictures have followed its use; indeed, under the most favourable circumstances urethral stenosis follows in two out of three cases. It is this vanguard of strictures which has called the operation to question. Even Guyon eventually began to doubt the advisability of the method. (Iselin,[25] Desvignes.[1]) For many years end-to-end anastomosis over an indwelling catheter has occupied the pride of place in text-books[4, 15, 26, 27] and teaching, and, consequently, the practice of British surgery. The end-results have hardly justified this trust. Other methods will therefore be reviewed, indicating as far as possible their relative merits and special uses.

The Sutureless Operation.—Rutherford,[4] of Glasgow, reported (1904) a very instructive series of cases treated by his sutureless method, which, in principle, is the very antithesis of end-to-end anastomosis. The operation consists of immediate suprapubic cystotomy followed by perineal section. A catheter is introduced from the meatus to the bladder, and the perineal wound left widely open. His argument for omitting suture is that whilst the gap between the ends of the urethra may be considerable when the patient is in the lithotomy position, yet, when the legs are extended, the ends of the urethra will be in contact. The results of his operation appear to be good, for five out of seven cases were found by him to be stricture-free at long intervals after operation. At the present time a sutureless operation is practised at the Besley-Osgood Clinic,[28] and the results are reported as being satisfactory.

The sutureless method is undoubtedly *the* operation when extravasation has occurred, for, as Besley emphasizes, suturing is technically impossible in the presence of infection or extravasation. If it is attempted under these conditions, sutures simply cut out and add still further to the destruction and loss of tissues.

Following modern principles, it would be advisable to omit the catheter and to pack the wound lightly for twenty-four hours. It is certainly difficult to dispel the idea of the necessity for a catheter when sutures have been omitted. If the roof has not been stitched, it is only natural to foster a conception that a catheter along the whole length of the urethra

will act as a splint, and this is probably correct. If the catheter is only retained twenty-four to forty-eight hours, it is improbable that harm will result from its use.

Suture of the Roof Only.—Rutherford Morison[29] introduced this method, and the principle has received much support from the Newcastle school. The roof is sutured by interrupted catgut stitches. If combined with suprapubic cystotomy, the catheter can be completely dispensed with. The wound is left open and lightly packed with moist strip gauze. This appears to be the best operation in those cases which are uncomplicated by extravasation. I have carried it out on three occasions,* and, aided by preliminary suprapubic cystotomy, have found it an easy operation.

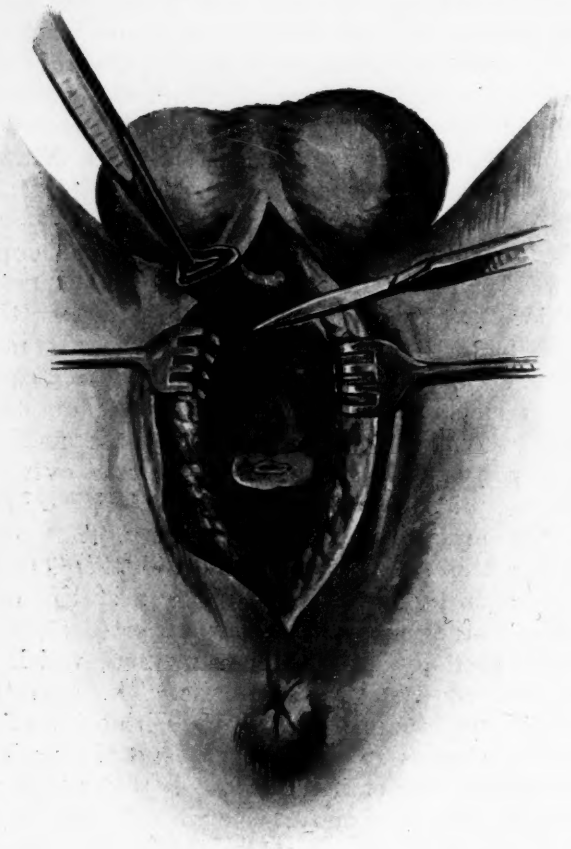

FIG. 252.—Mobilizing the cut end of the corpus spongiosum. (*After Marion.*)

Technique.—Preliminary suprapubic cystotomy having been performed, a Lister's sound is introduced down the internal urinary meatus. A liberal supply of gauze is wrapped round the sound, and this forms an excellent protection to the wound during subsequent manœuvres. A towel is then placed over the gauze and the bougie, leaving the handle free for an assistant to hold. Next the patient is placed in the lithotomy position, and, a second bougie having been passed from the external meatus, the

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* AFTER-RESULTS OF THESE CASES.—

Case 1.—The early urethroscopic appearances are depicted in this article (*see Figs.* 254, 255). It is now three and a half years since the operation. The patient has had no dysuria, and it is eighteen months since bougies were passed. On October 17, 1927, the urethroscopic appearance was much the same as it was three months after the accident (*Fig.* 255).

Case 2.—Urethroscopy eleven months after the accident. No stricture could be seen. Lister's 14/16 passed readily. Seventeen months after accident 14/16 still passed with ease.

Case 3.—Urethroscopy five months after the accident. Two veil-like folds in the bulbous urethra. Lister's 16/18 passed readily.

perineum is opened by a mid-line incision. Both ends of the urethra are at once accessible. The external bougie is removed, and the assistant is instructed to withdraw the internal bougie until the point is conveniently out of the field of operation. The roof is sutured by interrupted catgut stitches, and, in order to avoid these cutting out, a firm grip of the corpus spongiosum, as well as the mucous membrane, should be taken. After the suturing has been completed—two or three sutures suffice—the wound is lightly packed with strip gauze, and, dressings having been applied, the patient is taken down from the lithotomy position and a suprapubic tube is stitched into place. A De Pezzer's tube is useful for this purpose.

Owing to wide separation of the ends of the urethra, it will occasionally be found impossible to bring the divided ends of the structure into apposition by the method detailed above. In one such case I used a mattress suture, and after this had been introduced, but before it was tied, the patient was moved further up the table in order to lessen tension caused by the lithotomy position. By these means the ends of the urethra could be almost approximated. Ten months later the patient showed no signs of stricture on urethroscopic examination, and a 14/16 silver bougie readily slipped into the bladder.

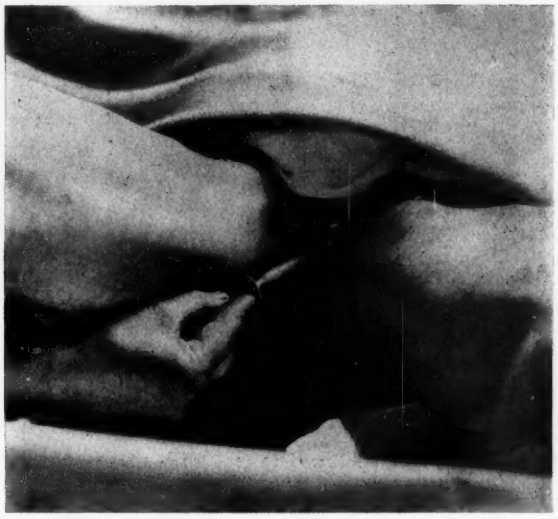

FIG. 253.—Irrigation of the perineal wound with eusol through a Higginson's syringe.

Probably such an excellent result is due more to luck than to good management. When the ends of the divided urethra are difficult to approximate it would probably be better surgery to mobilize the anterior end of the corpus spongiosum[42] (*Fig.* 252) before attempting suture.

After-treatment.—As suggested by Sir John Thomson-Walker,[45] the foot of the bed should be raised on blocks, so as to aid the emptying of the bladder by the suprapubic route. The proximity of the perineal wound to the anus makes infection almost a certainty, and special precautions are needed to ensue healthy granulation, which means so much in the prevention of stricture formation. To this end the bowels should be kept confined for the first four or five days; the perineal wound should be irrigated twice daily, and the introduction of eusol solution by means of Higginson's syringe (*Fig.* 253) has been found a trustworthy method for this purpose. Irrigation should be commenced as soon as the packing is removed, and persevered with for a fortnight.

Not until the twelfth or fourteenth day is it necessary to commence instrumentation. Before this is undertaken the meatus should be cleaned up and the urethra irrigated with a solution of 1 per cent mercurochrome or

1–10,000 silver nitrate. One well-lubricated Lister's sound is introduced, exercising the 'rule of the bougie', *arte non vi*, to its fullest degree.

Frank Kidd[3] has laid great stress upon the necessity for a urethroscopic control (*Figs.* 254, 255) in the after-treatment of ruptured urethra. It is only by repeated use of the urethroscope that we can estimate the need or otherwise of dilatation, and judge the end-result of treatment by various methods.

The Method of Pasteau[30] and Iselin.—At the initial operation both ends of the divided urethra are sutured to the skin of the perineum. A perineal fistula results. Urethral dilatation is continued weekly, until the tissues around the orifice of the perineal fistula are supple; this usually takes from four to six months. The second stage—a plastic—is then undertaken. A flap of skin is mobilized on each side of the middle line, one of which is hinged medially and the other laterally. These are superimposed one upon the

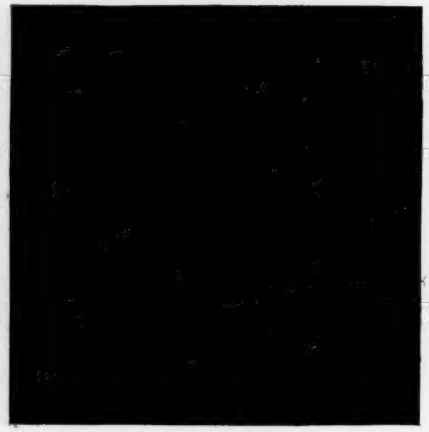

FIG. 254.—Complete rupture of the bulbous urethra treated by suture of the roof. Urethroscopic appearance during the sixth week after operation.

FIG. 255.—Same case as *Fig.* 254, three months later. An irregular scar is seen on the floor. A 17/19 bougie passes with ease.

other in such a way as to form a shutter lined inside and outside by skin, and this forms a new inferior wall to the urethra.

A late complication which is often in evidence after this method has been employed is the growth of hair within the new urethra, upon which phosphates are deposited. The growth of hair can be obviated to some extent by treatment of the skin from which the flap is to be made by electrolysis some weeks before the second operation.

This method yields very gratifying results (Savariaud[43], Legueu), but it is a long and somewhat tedious process.

Heitz-Boyer's Operation[21, 31].—The experience gained by the excision of strictures is the foundation of this procedure. The essential features are the resection *en masse* of the bruised tissues of the superficial perineum and the lacerated portion of the bulb. The anterior end of the divided corpus spongiosum is then mobilized, and an end-to-end anastomosis is performed between healthy portions of the urethra, over a large catheter, which is

removed *immediately* after the completion of the operation. Suture is possible if the gap in the urethra after the resection is less than 5 cm.

Marion, whilst practising an operation on much the same lines as the foregoing, emphasizes the fact that the resection should be reduced to a minimum—merely a trimming of the lacerated ends of the urethra.

Both authors stress the necessity of diverting the flow of urine suprapubically during the process of healing.

INTRAPELVIC RUPTURE OF THE URETHRA.

Intrapelvic rupture of the urethra is a more serious condition than the foregoing. The mortality is higher, the immediate diagnosis more difficult, and the treatment less satisfactory. The lesion is almost always an accompaniment of a fractured pelvis, and shock is often very pronounced. In country districts the accident seems to be characteristic of the hunting field, the horse rolling on the prostrate rider (Bond,[32] Wheeler[33], Rousseau[34]), but in town life street and industrial accidents account for a number of these cases.

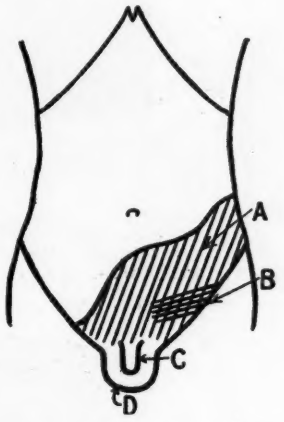

FIG. 256.—The physical signs recorded in a case of intrapelvic rupture of the urethra complicating a fractured pelvis. A. Deep-seated swelling (tender); B, Superficial bruising; C Blood from meatus; D, Perineum nil. There was grating on compressing the iliac crests.

Diagnosis.—Signs of fractured pelvis are usually evident. The patient has not passed urine since the accident, and the escape of blood via the meatus is a common occurrence. On examining the abdomen a swelling may be felt in the hypochrondrium. Extravasation into the pelvic fascia occurs early, and, curiously, it usually proceeds more on one side than the other (*Fig.* 256)—I have noticed this on two occasions. Unless the rounded dome of the bladder can be palpated distinctly from the rest of the swelling (the extravasation), it is impossible, by clinical methods, to make a differential diagnosis between extraperitoneal rupture of the bladder and intrapelvic rupture of the urethra. In this variety of rupture of the urethra there is no perineal swelling, but ecchymoses may be present. (Masmonteil.[35])

Treatment.—The investigation of the case should, as in the preceding type, be undertaken in the operating theatre whenever possible. Deanesly[36] warns us to be watchful lest the passage of a catheter into the prevesical space, and the withdrawal of a few ounces of blood-stained urine from this situation, be mistaken for an entry into the bladder. This is a trap into which many have fallen.

The operation is commenced by making a suprapubic incision which opens the cave of Retzius. Usually, only after this has been done is it possible to distinguish between an extraperitoneal tear of the bladder and an intrapelvic rupture of the urethra, and even then, amidst the blood-stained effusion, it may not be easy to determine the exact site of the lesion. The guiding rule is: if the bladder is even moderately distended,

the lesion must be situated below the vesical sphincter.[37] Thus the diagnosis of intrapelvic rupture of the urethra is confirmed. (*Figs.* 257, 258.)

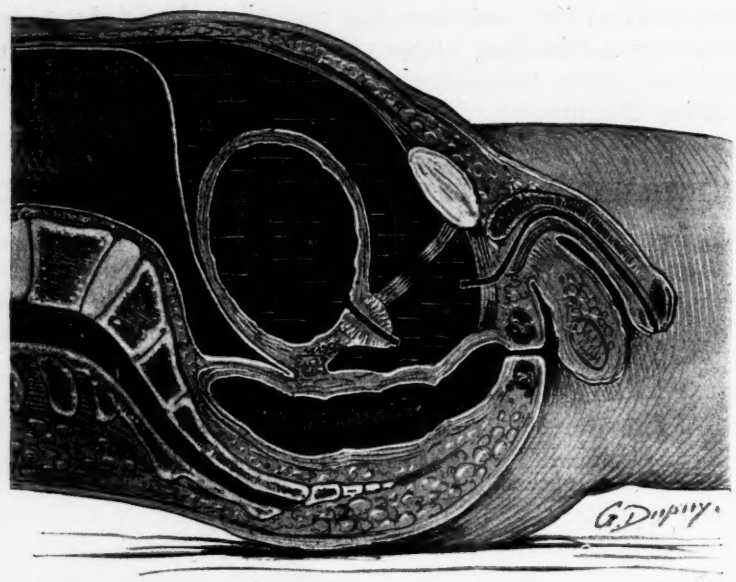

FIG. 257.—Intrapelvic rupture of the urethra. The puboprostatic ligaments are torn, and the bladder, which may be moderately distended, becomes displaced backwards. (Cf. *Fig.* 258.)

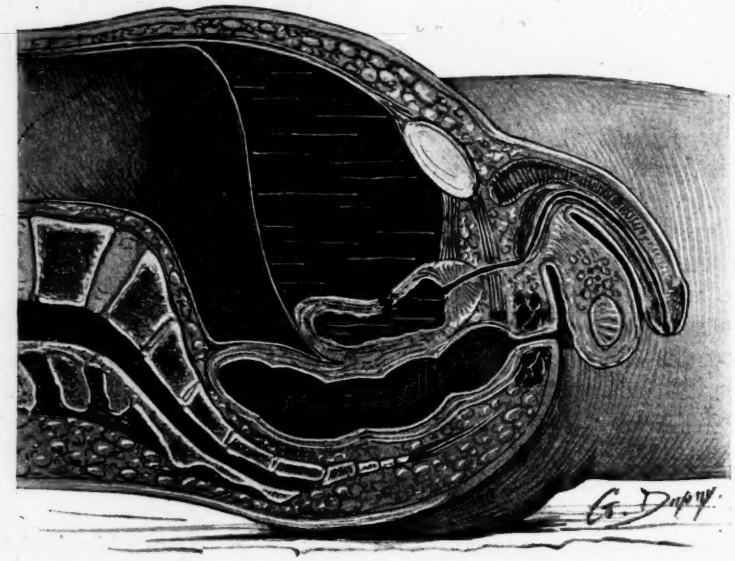

FIG. 258.—Extraperitoneal rupture of the bladder. (Cf. *Fig.* 257.) The bladder is empty or practically so.

The immediate treatment of this accident is often limited to suprapubic cystotomy and drainage of the cave of Retzius. Whilst this measure

commonly saves the life of the patient, it should be emphasized how essential it is to go further and make some provisions for the restoration of the continuity of the urethra before it is too late.

Intrapelvic rupture of the urethra frequently occurs at the apex of the prostate—in other words, the prostatic urethra is severed from the membranous portion. In addition, the puboprostatic ligaments are torn (Deanesly.[36] Hartley Anderson[38]). The loss of these ligaments, aided no doubt by the pressure of the extravasated products in the cave of Retzius. causes the neck of the bladder, with the prostate, to become displaced backwards (*Fig.* 259). It is this backward displacement which accounts for the hopelessness of remote restoration of the continuity of the canal; and if it is not rectified at the initial operation or very soon afterwards, we are bound to meet with the following depressing aftermath, which must be fairly common, for I have encountered three examples, and have been responsible for one :—

A boy presents himself at surgical out-patients with a suprapubic fistula. The sinus is unhealthy and discharging purulent urine. He may have been fitted with a permanent suprapubic belt, but the reason for his appearance is that the fistula has closed down and will not admit the catheter. An examination of the perineum reveals an old scar, and there is a history of a fractured pelvis, rupture of the urethra, suprapubic drainage, and drainage of the cave of Retzius. At a later date (usually when the fracture has united) an attempt, or more often several attempts, have been made to restore the continuity of the urethra, but without success. Continually wet and smelling of urine, subject to recurrent attacks of cystitis and pyelitis, these cases are poignant examples of what Rutherford Morison so aptly refers to as 'life-long tragedies'.

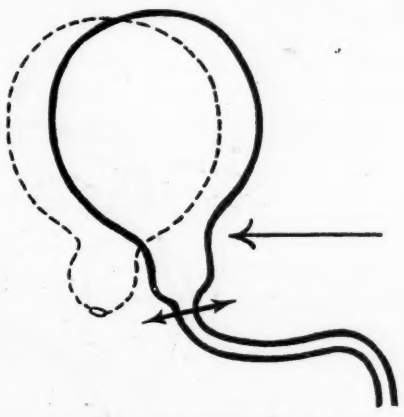

Fig. 259.—The mechanism of backward displacement of the bladder. The urethra having been severed near the apex of the prostate, and the puboprostatic ligaments having been torn, the pressure (arrow) of the extravasated products in the cave of Retzius causes the neck of the bladder to be displaced backwards.

Permanent suprapubic drainage is therefore most undesirable, especially in a young subject. It *can* be prevented, but only by correcting the backward displacement of the neck of the bladder before it becomes anchored in its abnormal position. If this correction is carried out at the time of the initial operation or very soon afterwards, there is every hope of eventually restoring the continuity of the urethra.

Methods of Correcting Backward Displacement of the Neck of the Bladder.—*Direct Suture of the Urethra.*—At the present time it can hardly be said that direct suture of the intrapelvic variety of urethral rupture is very practicable. The patient is almost always considerably shocked—shock is very much more pronounced in this type of rupture than in rupture of the bulbous urethra. We are thus prohibited from attempting a deliberate operation. Direct suture of the intrapelvic variety of rupture must always be deliberate, for it is, at the best, a difficult procedure which must be conducted at the

bottom of a deep and hæmorrhagic cavity. A transverse incision close to the anus,[40] the use of Young's prostatic retractor (Hartley Anderson[38]), and the very exaggerated lithotomy position (Gaub[41]) are lines along which these technical difficulties will eventually be overcome. The probable solution of the major difficulty—namely, shock—lies in a two-stage operation, whereby the bladder and the cave of Retzius are preliminarily drained, and forty-

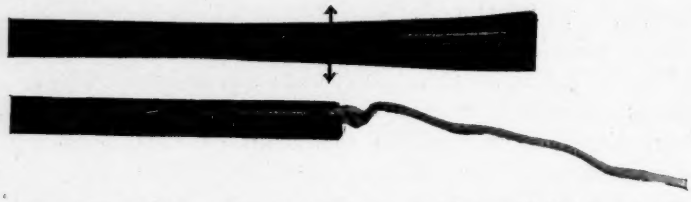

FIG. 260.—The bulbous extremity of the gum-elastic catheter is cut off and a length of silk is attached to the cut end. The catheter may then be changed by the 'railroad' method.

eight hours later the perineal stage is undertaken. This, theoretically, overcomes the principal obstacle, yet in practice we may find that at the end of forty-eight hours the patient is still unfitted for a major procedure. Even if this is not the case, it is possible that permission for further operation may not be granted. Two-stage operations with a short intermediate phase seldom retain a permanent place in accepted surgical methods.

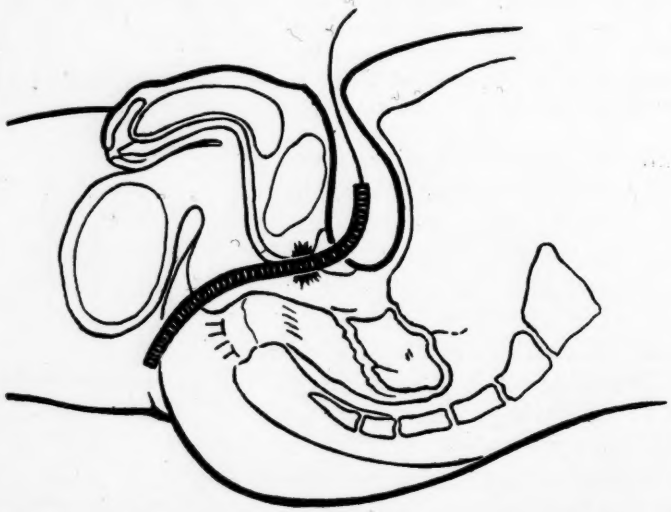

FIG. 261.—Complete intrapelvic rupture of the urethra. Backward displacement of the neck of the bladder corrected by an indwelling catheter. Note the silk attached to the catheter to facilitate changing.

Correction by an Indwelling Catheter.—Backward displacement can be corrected by the simple expedient of passing a retrograde bougie and cutting down upon this in the perineum. A gum-elastic catheter is then passed from the bladder to the perineum. Before introducing the catheter it is a wise precaution to cut off the dilated extremity and to pass a needle carrying silk

through one side of the cut end (*Fig.* 260). If the silk is left hanging out of the suprapubic wound, the catheter can subsequently be changed by the 'railroad method'.

Bond[32] has pointed out that in order to introduce the catheter it is not even necessary to put the patient into the lithotomy position. The sound may be cut down upon after gently separating the partially flexed thighs. Even in the gravest cases this additional manipulation can add but little to the time and shock of the operation. Once a catheter has been passed from the bladder to the perineum, the posterior end of the urethra is under control (*Fig.* 261).

If time permits, the catheter can be threaded through the whole length of the urethra and made to emerge at the external urinary meatus; but there is no advantage to be gained by this in the early stages of treatment.

After all the condemnation the indwelling catheter has received in the earlier part of this paper, it may at first sight appear inconsistent to terminate by advocating its use. I therefore hasten to emphasize that the *only* indication for the retained catheter in urethral injuries is in a complete *intrapelvic* rupture. We are dealing here with a very grave and desperately urgent accident, where simplicity of technique is of paramount importance. Fortunately, it so happens that the very objection to the retained catheter—i.e., its stimulating effect on formation of fibrous tissues, of such great moment in lesions of the bulb—is of practically no account here. *The membranous urethra, unlike the bulbous, shows very little tendency to stricture formation.*[2] Apart from this fortunate coincidence, the indwelling gum-elastic catheter, in its rôle of correcting backward displacement of the bladder, more than justifies its place as a standard method of dealing with this difficult situation.

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CONGENITAL ABSENCE OF THE HUMERUS.

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For some reason unknown, congenital absence of the humerus would appear to be the rarest of all defects of the long bones. Congenital absence of the ulna is also a rarity, whereas a total or partial defect of the radius, which is generally associated with club-hand, is of commoner occurrence. Bibliography is very scanty. Gittings[1] quotes a case of congenital absence of the humerus with a rudimentary attempt at radius and ulna. Herczinger[2] quotes a case of congenital absence of the humerus alone. Unfortunately I have not been able to verify this reference. Ollerenshaw[3] has seen a case of bilateral absence of humerus, ulna, and radius—the hands being attached to the shoulders. Sir Arthur Keith tells me that there is no instance of the condition in the R.C.S. Museum, but that one skeleton of a full-time child has a humerus represented by a bar of fibrous tissue. In the case of Gittings there was no articulation at the shoulder-joint, the union being purely fibrous. As regards etiology, he states four admissible causes—maternal impressions, intra-uterine constrictions, local arterial disease, or some deficiency in the original germ cell. Successful radiographs were not possible.

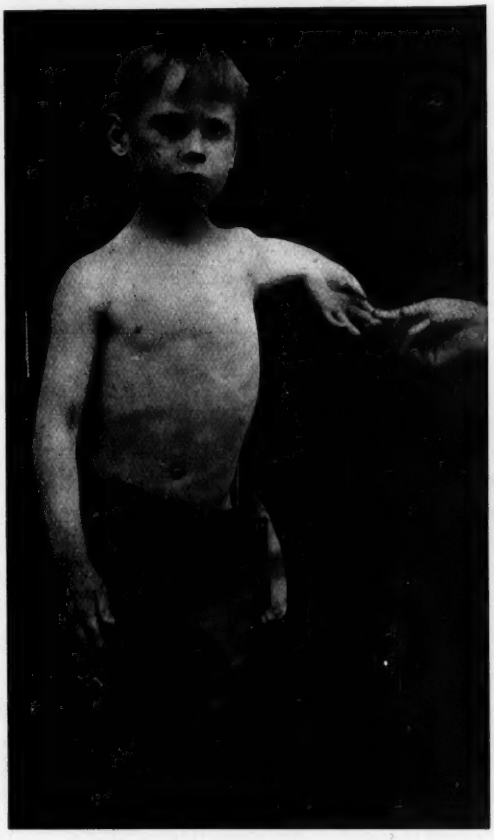

Fig. 262.—Shows limit of passive extension and adduction.

A boy of 8 (*Fig.* 262), one of a family of three, apart from the deformity is strong and healthy, and was born at full time. A sister suffers from poliomyelitis. The mother tells me that there has been no deformity to her knowledge either in her family or that of her husband. She states that she had a fright at the fourth month of pregnancy with this child.

Radiographs show partial absence of the ulna at its lower third, and the

bone is small. The radius is boomerang-shaped, disproportionately large, and its upper end overlaps the upper end of the ulna (*Fig.* 263). The articulation of which the upper end of the radius comprises the greater part, would appear to rest on the axillary border of the scapula an inch below the ill-developed glenoid. There is marked ulnar deviation of the hand. In the position of rest the arm is held 30° in abduction from the shoulder and in full supination, so that the palm of the hand is held square to the front. Passive extension of the arm is not possible beyond the mid-axillary line.

FIG. 263.—Shows false joint below the glenoid cavity, also the defect of the lower end of the ulna.

Voluntary Movements.—Abduction to 90° is possible, but only when the arm is flexed to 45° in front of the mid-axillary line. It would appear that the pectoralis major primarily fixes the upper end of the arm into position beneath the glenoid, and that abduction is then produced by the rotators of the scapula. The boy has all the scapular muscles, and individual action was examined of the trapezius, supra- and infraspinatus, latissimus dorsi, and subscapularis. Flexion of the arm to 80° is brought about through the agency of the major pectoral. Metacarpo-phalangeal and interphalangeal movements are good, but opposition of the thumb is imperfect. Dorsiflexion of the wrist is impossible, and flexion is limited, being only 75 per cent of normal. The child can use the hand quite well, and when a coin is held in front of him he will take it from the donor and transfer it to his upper outside jacket pocket with creditable speed.

My thanks are due to Dr. Llewellyn Williams, D.S.O., of Mountain Ash, who brought the case to my notice.

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TORSION OF THE GREAT OMENTUM: A NOTE ON TWO CASES.

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The literature on torsion of the great omentum is sufficiently scanty to justify putting on record two cases which have recently occurred in my own practice. In view of the fact that these are the only cases of the kind with which I have come in contact, their occurrence in rapid succession bears out the experience of most surgeons that rare conditions not infrequently appear in groups.

Case 1.—P. K., male, age 25, was admitted to Mater Misericordiæ Hospital on April 15, 1927. There was a history of vague dyspepsia for some years. On the previous morning he experienced a sudden, not very severe, pain in the right iliac region. Shortly after the onset he took castor oil, and the bowels moved the same day, but without relief of the pain. He vomited once. The patient was a small slim man; pulse 86, temperature 100°, respirations 20; tongue furred; abdominal movement restricted. Slight rigidity and marked tenderness in the right iliac fossa. No hernia. A diagnosis of acute appendicitis was made.

Operation.—The abdomen was opened by a right pararectal incision. When the rectus muscle was displaced inwards one noted, with surprise, distinct œdema of the peritoneum. When the peritoneum was opened some blood-stained fluid escaped, and one immediately felt a finger-like thickening adherent to the anterior abdominal wall just within the line of incision. The thickened structure was easily freed and delivered, when it was found to be a portion of the right margin of the omentum, which was purple and strangulated from a twist at its base. The affected portion of omentum was removed, as was the appendix, which appeared congested. The abdomen was closed.

The patient made a good recovery and was discharged on April 28.

Case 2.—P. G., age 48, a very stout man, was admitted to Mater Misericordiæ Hospital on May 25, 1927. He had experienced a dull pain about the umbilicus on May 21; he took Epsom salts and the bowels moved on the 23rd, but the pain was unrelieved. There was no vomiting. Pulse 100, temperature 99°, respirations 24; tongue furred; abdominal movement restricted. An indefinite but very tender mass was felt in the right iliac fossa, and there was an old-standing right inguinal hernia. Diagnosis: acute appendicitis? with abscess.

Operation.—The abdomen was opened by a transverse incision on the right side just below the umbilicus. There was well-marked œdema of the parietal peritoneum and extraperitoneal fat. When the peritoneum was opened blood-stained fluid escaped, and a purplish mass presented, which in the light of my former experience I quickly recognized as strangulated omentum. The mass was widely adherent to the anterior abdominal wall, but was freed and delivered with remarkable ease. The right side of the omentum was involved. The mass was ligatured below the twist and removed. Its appearance is well shown in *Fig.* 264.

The patient made an excellent recovery, and was discharged on June 12.

The clinical picture of this condition is well described by Cowell in the BRITISH JOURNAL OF SURGERY,[1] to which the reader is referred for a complete account and an excellent bibliography. In my first case the diagnosis of acute appendicitis was made with confidence; the second case was thought to be one of appendicular abscess on account of the tender mass, although a little reflection might have suggested that the development of such a large mass was rather rapid for a case of appendicitis. In both cases the right portion of the omentum was involved, the strangulated part being in the first case only a slender process, and in the second a mass the size of two fists—

FIG. 264.—Front and back views of the portion of omentum removed in *Case* 2.

a difference which corresponds with the build of the patients, one being very slim and the other very stout. In the second case a hernia was present, but it bore no apparent relationship to the twist. In both, the affected portion of omentum was adherent to the anterior abdominal wall, which sufficiently explains the parietal œdema noted in both. The lightness of the adhesions—a characteristic feature of these cases—was as remarkable as it was gratifying. The presence of œdema was particularly puzzling in the first case, where operation was performed on the second day of the attack, as one associates this condition only with a neglected appendicular abscess. The presence of such early œdema, especially when followed by

the exit of blood-stained peritoneal exudate, should render one alive to the possibility of omental torsion in urgent abdominal operations. It is conceivable that the condition might be overlooked when the abdomen is opened by a gridiron incision, especially if, as in my first case, the affected portion of omentum were quite small and operation were carried out very early in the attack.

REFERENCE.

[1] COWELL, ERNEST, "Abdominal Torsion of the Omentum", *Brit. Jour. Surg.*, 1925 xii, 625.

THE STABILIZATION OF THE FLAIL LEG.

By H. TYRRELL GRAY,

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This communication constitutes a plea for the revision of the accepted views on the subject of arthrodesis of the knee in cases of extensive infantile paralysis of the lower limbs. The advocacy of such a procedure depends on the recognition of two essential principles: (1) Patient treatment on accepted lines, together with the correction of deformities where necessary, must prove the impossibility of any further return of muscular power; and (2) Such treatment must be carried out under supervision for some years—a minimum of two years has been arbitrarily chosen as the time limit beyond which further improvement is not to be expected.

The cases selected for operation fall into two groups: (1) Those where the lesion in the cord is so extensive that there is no return of muscle power whatever; and (2) Where the degree of recovery is so small that the limb can never support the body weight without the help of irons so cumbersome as to constitute a serious impediment to walking. Practically all the cases quoted fall into the first group; in the second group judgement should err on the side of conservatism. The aim of the operation must be solid bony union at the knee-joint, and the achievement of this must be certain. Such absolute certainty can only be ensured by the use of a bone-graft. The writer has used this method for eight years, and has had no failure of bony union.

THE OPERATION.

The operation is performed throughout after a tourniquet has been applied. If no blood is lost the whole procedure can be carried out at any age, under gas and oxygen anæsthesia, with no shock and the minimum of disturbance to the patient.

1. A small spicule of bone, together with the overlying periosteum, is removed from the crest of the tibia. The graft is about three inches in length, and need be no more than a third to one quarter of an inch in thickness; it is preserved in dry gauze, and the wound closed. It is immaterial whether the graft be taken from the leg to be operated on or from the other side. The use of a chisel or the Albee saw is a matter of choice.

2. The knee-joint is exposed by the usual semicircular incision, dividing the ligamentum patellæ. All cartilage is removed from the articular surfaces of the patella, condyles of the femur, and the tibia, together with the semilunar cartilages. With a fine gouge, a hole is drilled through the epiphyses of both tibia and femur, and the graft is inserted well into the diaphysis of both bones. Over this graft the knee is straightened and the denuded

surfaces are approximated. The capsule and ligamentum patellæ are closed by a continuous catgut suture, and the skin is closed by a subcuticular salmon-gut stitch. After a firm bandage has been applied the tourniquet is released and the limb put into a light plaster splint with a window at the operation site. When the swelling has subsided (in about ten days or a fortnight) a fresh plaster is applied, which is removed in two months. Bony union has then occurred throughout the whole extent of the denuded articular surfaces.

Though there has been no failure to obtain ankylosis in any of the series, a few cases will be reported which illustrate instructive points relating to the selection of cases and operative details. I have been unable to follow up several cases that were operated upon seven or eight years ago, but in two of these the end-result was instructive.

FIG. 265.—Shows bony result eight years after operation (22 years of age).

1. In two instances in the earliest cases *post-operative swelling and œdema* was marked. The first instance was that of H. A., male, age 12 years. Massive œdema lasted as long as I had him under observation. After some years I lost sight of him and could not trace him. I had reported the œdema as permanent; but, by a curious coincidence, as this communication was being posted, he came to consult me about his leg, and I have revised and rewritten his case. The œdema has completely disappeared with the lapse of time; but the growth of the limb has taken place so irregularly that there is a marked genu valgum deformity of about 30°. It is difficult to understand why this overgrowth of the internal condyle should have taken place, since the skiagram (*Fig.* 265) shows the graft inserted centrally. Also it is the only instance of such a deformity in the series.

The second instance was that of M. P., female, age 14 years. Extensive involvement of the lateral-horn cells was evidenced by the coldness and blueness of the limb, as well as by the liability to recurrent chilblains. She had never walked without support, and there was no reaction of the muscles to faradic stimulation. In 1919 a bone-graft was removed from the sound side and arthrodesis performed in the manner described. Arthrodesis of the ankle-joint was performed in 1921. This girl, now 21 years of age, consulted me this year for persistence of the massive œdema, which rendered the weight of the limb (now stable and straight) a considerable disability in walking.

These are the only two cases in which the end-result has been vitiated—one by irregular growth and the other by persistent massive œdema. In the first case the post-operative œdema may have been due to the tourniquet, but in the second case this cannot account for its persistence for so many years. I believe that extensive vascular changes and chilblains are a contra-indication to this operation. Blueness and chilblains on toes or feet do not necessarily contra-indicate operative measures, since several cases of this type have ended satisfactorily without any such complication; but extensive vascular changes in leg and thigh are to be considered an unfavourable sign.

2. That very extensive *paralysis, marked wasting, and shortening* may be greatly benefited by this operation is shown by the following case:—

CASE 1.—B. D., male, age 8½ years. Severe poliomyelitis affecting the right limb at 3½ years. Treated continuously in the out-patient department for five years with no improvement. Never walked without splints. Left leg unaffected. On Sept. 16, 1918, the electrical reactions showed only a flicker in the hamstrings. On Oct. 8 arthrodesis of the right knee was performed, a large bone-graft being taken from the left tibia. On Nov. 11 the limb was put up in a plaster-of-Paris splint. Firm bony union resulted.

Operation for arthrodesis of the ankle-joint was performed in 1919 (a year later). Skiagrams showed the size of the bone-graft to be unnecessarily large. This patient was kept under observation for some years, but has recently been lost sight of. In spite of great shortening and wasting, he ran very quickly and played football. He has never worn any supports since his first operation.

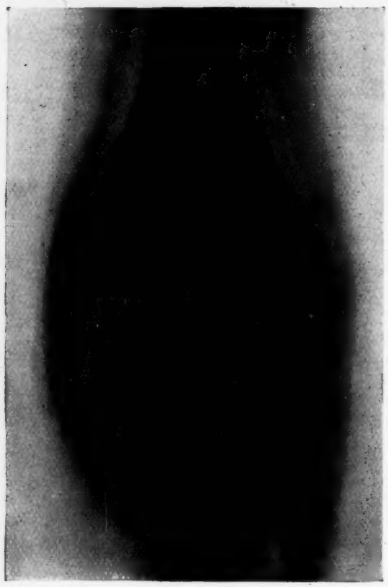

FIG. 266.—*Case* 2. Shows the result of bone-grafting without denuding the cartilaginous surfaces, i.e., the portion of the graft which lies in the joint cavity becomes gradually absorbed and full movement is ultimately established.

3. In this case I determined to see whether the introduction of a bone-graft, *without denuding the cartilaginous surfaces*, could effect a bony union. The details are as follows:—

CASE 2.—K. A., female, age 8 years. Severe poliomyelitis in babyhood (at 2 years) involving both lower limbs. Treated (first at another hospital, and subsequently at Great Ormond Street) with massage, electricity, correction of deformities by splinting, tenotomies, etc.

Jan. 8, 1919: The electrical reactions were as follows: *Right limb*: adductors and hamstrings active, also flexors of toes. *Left limb*: paralysis complete. The child had never walked without supports, which were constantly under repair as she grew bigger and heavier. She developed into a very heavy child.

Feb. 10: A large graft, ½ in. by ½ in., and 4 in. in length, was removed from the right tibia. *No cartilage was removed* from the left knee-joint, but the graft was inserted, and the capsule and skin were sutured in the usual way. The limb was placed in plaster-of-Paris. The gradual absorption of the intra-articular portion of the bone-graft (presumably by the action of the synovial fluid) is shown by the skiagram of the knee-joint (*Fig.* 266) two or three months later. The intraosseous

portions of the graft are plainly visible. Complete movement at this joint was then restored. This simplification of the operation failed to achieve the desired result.

Oct. 14, 1920 : Arthrodesis of left knee. Bone-graft removed from left tibia. Left knee-joint opened through the old wound, the cartilaginous surfaces denuded, and the graft inserted as before. The limb was placed in plaster-of-Paris with windows at the site of both wounds. Bony union resulted, as shown by skiagrams taken in June, 1922 (*Fig.* 267), and in April, 1923 (*Fig.* 268).

June 12, 1922 : Operation for arthrodesis of left ankle-joint and tendon fixation.

Previous to operation this child had only been able to drag herself about laboriously and with infinite physical effort with cumbersome irons connected by a pelvic band, and with the aid of two sticks. Now she can stand unsupported

FIG. 267.—*Case* 2. Shows the same case as *Fig.* 266, where, subsequently, the cartilaginous surfaces were denuded and the bone-graft inserted—complete bony union resulted.

FIG. 268.— *Case* 2. Shows the same as *Fig.* 267, ten months later. The evidence of the several grafts is still visible, but the epiphysial line *appears* little affected. The relative length of the two limbs appears to be unaffected (both being extensively involved).

and walks alone with light supporting irons on the right limb. In evidence of the firmness of the bony union resulting from this operation, it is interesting to note that in April, 1921 (six months after arthrodesis of the left knee), this child slipped and broke the left leg at the junction of the middle and upper thirds of the tibia —*not* (as might have been expected) at the site of the bone-graft.

Further treatment was directed towards correction of deformity and maintaining good position in the right limb. This patient is now a big and heavy girl, but is able to get about satisfactorily with no support to the left limb.

4. The next case is of interest from the point of view that sufficient damage may be done to the epiphyses of the femur and tibia by this operation to retard or impair growth in a limb whose growth has already been impaired

by the disease. This is an exceedingly difficult point to assess at its true value. In the cases so far reported the graft used was large ; but, in the face of such uniformly satisfactory union, progressively smaller grafts have been used—indeed, a spicule of bone is all that is necessary. If the whole extent of each epiphysial surface is borne in mind, it is clear that only a very small area is damaged by the graft, and little, if any, interference with growth should be expected. When both limbs were extensively involved (as in *Case* 2) I could not satisfy myself that there had been any material impairment of growth after two operations by bone-grafting.

CASE 3.—C. D., male, age 10 years, was under treatment on the fifth day of illness at the age of 1 year and 5 months. He was treated continuously under my care for nine and a half years. The disease only involved the right limb, in which (after this

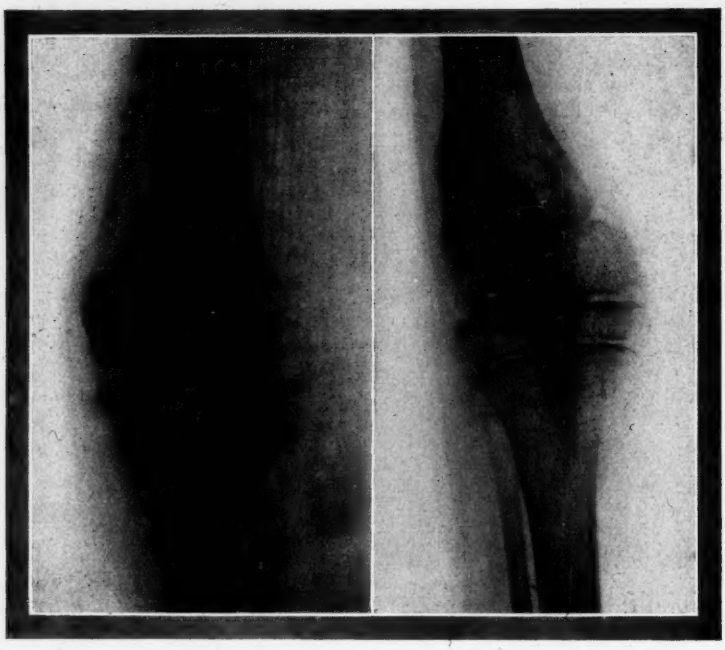

FIG. 269.—*Case* 3. Shows the graft seven weeks later—commencing bony union can be seen.

time, November, 1923) there was only a weak adductor and flexor response. The limb, otherwise completely flail, was the seat of obstinate chilblains and was blue and swollen in its lower third.

Nov. 12, 1923 : Arthrodesis of the right knee. A thin bone-graft from the tibia of the affected side was used. *Fig.* 269 shows the result seven weeks later ; commencing bony union can be seen. *Fig.* 270 shows the X-ray appearances on Nov. 13, 1924, or a year after operation. Complete bony union has taken place, the graft has nearly disappeared, and the epiphysial line appears hardly disturbed. *Fig.* 271, taken in 1926, illustrates the stability of the limb and also gives a comparative picture of the normal with the affected side.

In November, 1923, the right limb was an inch and three-quarters shorter than the left, while in October, 1925, there was three inches of shortening,

i.e., an inch and a quarter increase in shortening in two years. The photographs showing the comparative integrity of the epiphyses and the extent of the paralysis and vascular disturbance in the limb would lead one to believe that most of this shortening must be attributed to the disease rather than to the operation.

FIG. 270.—*Case* 3. Snows the result one year later.

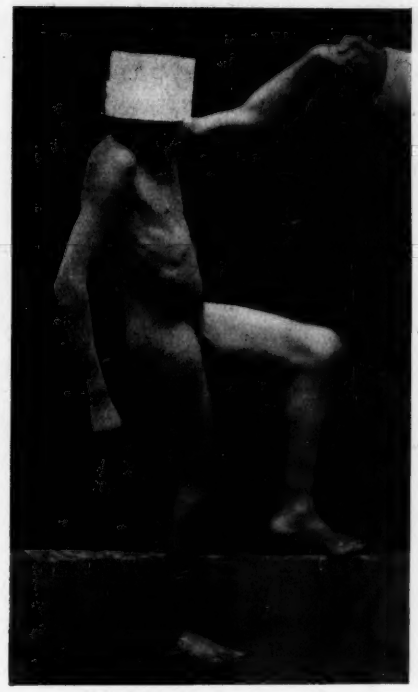

FIG. 271.—*Case* 3. Shows the final degree of stabilization achieved. Note the poor condition of the limb and unhealed chilblain.

FIGS. 272, 273.—*Case* 4. Show the result three years after operation.

5. The disappearance of the bone-graft and the integrity of the epiphysial lines are also well illustrated in a younger subject.

CASE 4.—K. P., female, age 6 years. April, 1920 : Arthrodesis of right knee—bone-graft from the left tibia. A skiagram taken three months later showed that bony fusion was incomplete. *Figs.* 272 and 273 (taken three years later) show the disappearance of the bone-graft to be nearly complete, and the epiphysial lines practically intact.

CASE 5.—L. B., female, 11 years and 3 months. Infantile paralysis, affecting the right leg only, at 4½ months. Arthrodesis performed on the right knee for flail limb nearly eleven years later (the ankle-joint had previously been fixed). Bony

FIG. 274.—*Case* 5. Showing bony union established in about three months.

union had taken place in three months. It is to be regretted that previous measurements of the two limbs are not recorded, but two years later the difference was two inches.

The degree of paralysis can fully account for this amount of shortening, which compares quite favourably with many cases not submitted to operation. It would appear that damage to so small an area of the epiphysis can hardly have contributed to any great extent. *Fig.* 274 shows the condition of the bones and graft three months after operation.

6. The remaining two cases to be reported are of interest from the fact that both were operated on within a week. In the first instance the graft was deliberately inserted through both epiphyses; in the second an effort

was made to preserve their integrity. This difference in the usual procedure was intended to ascertain: (1) Whether there was any ascertainable interference with growth arising from epiphysial injury; and (2) Whether the contact of the graft with the diaphysial side of the epiphysis influenced the rate or completeness of ossification.

CASE 6.—B. S., female, age 9½ years. Onset at 2 years and 8 months. Right limb under treatment from six weeks after onset. Shortening of the right limb was two inches, and the only serviceable muscles were the hamstrings.

Oct. 29, 1923: Arthrodesis of the right knee. In this case the graft was deliberately introduced through the epiphysis of femur and tibia. Union did not take place until the lapse of three months, and the patient was not allowed to walk until five months after the operation.

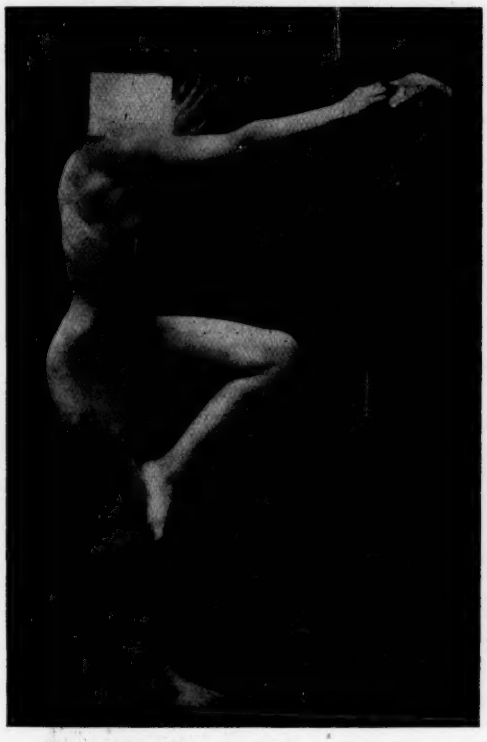

FIG. 275.—*Case* 6. Shows the degree of stabilization achieved. Note the slight and persistent swelling of the affected limb.

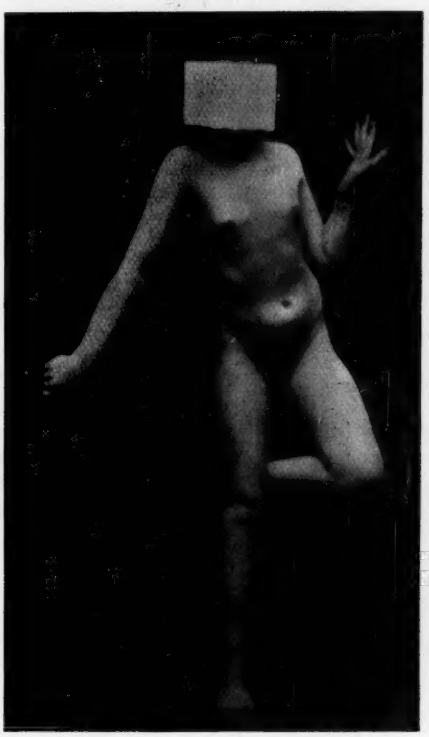

FIG. 276.—*Case* 6. Shows the child's ability to stand on the stabilized limb with practically no support.

A skiagram taken two years later showed that the graft had nearly disappeared, the epiphysial lines were almost intact, and there was no line of differentiation between the tibia and the femur. The affected limb is three and a quarter inches shorter than the sound limb. Two years after operation this child fell down and complained of pain in the right knee. Physical signs and skiagrams were negative, and she rapidly recovered.

Figs. 275 and 276 show the result three years later. Though she had never walked without supports, this child has now been walking without splints for over two and a half years. There is a little permanent swelling of the limb, but this is not sufficient to cause any disability or inconvenience.

CASE 7.—K. W., female, age 7 years and 9 months. Onset at 8 months. Both limbs extensively paralysed. Treated for nearly seven years. There was no muscular power below the knee on the left side, and very little on the right. The thigh muscles were good on the right side, and almost absent on the left. The left leg was one inch shorter than the right.

Nov. 5, 1923: Arthrodesis of left knee. In this instance every care was taken to avoid injury to the epiphyses concerned. It will be seen in *Figs.* 277 and 278 that after the introduction of the graft the epiphysis of the tibia appears to have been accidentally encroached upon in the approximation of the denuded surfaces over the graft. The shortening remained the same after operation.

FIG. 277.—*Case* 7. Shows the graft immediately after operation. It will be seen that the graft inadvertently encroached upon the tibial epiphysis.

Union took place six weeks after operation, and a skiagram taken two weeks later showed bony union had taken place but was not complete over the whole articular surface. Further skiagrams showed the condition of the bones and epiphyses five months after operation: bony union was complete, but the line of union was still evident. The epiphyses were practically normal. *Fig.* 279 shows the final result nearly two and a half years after operation.

FIG. 278. — *Case* 7. Shows the condition of bones and graft after two months.

This child had never walked without help, but now has walked for over two years without any appliance on the left leg and with the help of irons on the right leg. *Fig.* 280 shows the degree of stability attainable in a completely flail leg.

Tendon fixation has been performed by threading the distal ends of the divided extensors through a tunnel in the lower end of the tibia—half being brought through one way and half through the other—and fixed at the desired tension. The proximal ends have been then attached to their fellows below the site of the fixation to the tibia. In cases of lateral instability or deformity, a subastragaloid fixation or a further ankylosis (by Dunn's operation) may be necessary at a later age.

My colleague, Mr. Fairbank, with whom I have frequently had the privilege of discussing this question, is not in sympathy with arthrodesis at the

FIG. 279.—*Case* 7. Shows the condition of bones and graft after two and a half years.

ankle-joint. He thinks the ankle-joint is loose in the minority, while in the majority the normal range of hinge movement only is allowed. Accordingly he prefers Dunn's operation alone and abstaining from any attack on the ankle-joint. This can be combined with a toe-elevating strap for walking in cases of marked foot-drop. With these views I agree in cases where some muscular power exists; but in completely flail limbs I believe arthrodesis of the ankle combined with tendon fixation is of distinct benefit, and avoids the necessity for toe-elevating devices. This, after all, is the object of operating.

FIG. 280.—*Case* 7. Shows the degree of stabilization achieved.

Treatment of the Foot.—Since the object of operation is the elimination of splinting, some form of stabilization of the foot is called for. I have in most instances performed arthrodesis of the ankle-joint with or without tendon fixation. Arthrodesis consists of denuding the cartilaginous surfaces of the tibia, astragalus, and the malleoli. The resulting union is fibrous and allows of some movement over a small range; this degree of movement does not increase with the lapse of time, so that stability and mobility are achieved.

CONCLUSIONS.

1. Arthrodesis of the knee-joint should have a definite place in the surgery of infantile paralysis, provided bony union can be achieved with certainty. That this is possible in all cases at any age has been shown.

2. *Selection of Cases* should be based on the proviso that no further degree of recovery can be hoped for; the degree of permanent disability can be estimated. Cases will then fall into two groups:—

a. Completely flail limbs. In this group it is submitted that there is a clear case for the operation from two entirely different points of view. In the hospital class economy is effected by eliminating an expense which, in the majority of families, constitutes grave hardship. In all classes the tedious application of irons, constant supervision to prevent deformities and keep splints in order, disability resulting from the weight of splints, the resultant hampering of movement and limitation of activity—all these plead for a reasonable alternative such as can be provided by operation. In addition, valuable time to all concerned is saved and a useful and independent member of the community is created—a contrast to the comparatively helpless cripple demanding time and attention from others.

b. Where some muscular power exists. In this group the same arguments apply. Here, however, the advocacy of operation as against splinting depends on a careful consideration of the degree of paralysis, the particular groups of muscles in which recovery has taken place, and the ability of these muscles adequately to stabilize the limb. In this decision two main factors have to be considered in addition—namely, the weight of the patient and the weight of the necessary splint. It is clear that in this group any advocacy of operation must be postponed until an age when these factors can be assessed, and operations will only be undertaken on older children.

3. *Possible Objections to the Operation.—*

a. Risk. This is entirely negligible.

b. The disadvantages of a stiff limb, especially when sitting, would appear to be small in comparison with the tedious expenditure of time in putting on and taking off appliances.

c. Interference with growth. The operation can be done effectually without damaging the epiphyses. In any case the interference with the epiphyses is on so small a fraction of the whole area that it is difficult to conceive any great interference with growth. Epiphysial disease can result in lengthening, shortening, or no relative alteration, and this provides far more extensive interference. The difficulties of estimating the amount of increasing relative shortening when both legs or one only are involved make it impossible to say with certainty how much shortening is due to disease and how much to operation. In view of these considerations it is fair to regard the operation as comparatively innocuous in this respect.

d. It has been urged that the patients themselves should have the right to decide whether a permanently stiff limb is advantageous. Against this is the valid argument that a child's character and utility are formed and established respectively at an age when it cannot choose for itself. And the curtailment of the normal child's activities is a distinct disadvantage at an age when association with other children on equal terms is of great importance.

e. Finally, it may be urged that the views of parents as to the value of the procedure are not to be ignored. Both parents and older children themselves have experienced nothing but satisfaction. This satisfaction was only modified in the two early cases of massive œdema and irregular growth already reported.

I wish to express gratitude to my colleague, Mr. H. A. T. Fairbank, for his constant interest and valuable criticism, and to Dr. Bertram Shires for kindly taking the skiagrams.

ARTHRODESIS.

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(*Being the Presidential Address to the Orthopædic Section of the Royal Society of Medicine.* [*October* 4, 1927.)

I HAVE chosen arthrodesis as my subject because, looking back over the changes which have gradually evolved in bone and joint surgery since 1912 or 1914, it seems to me that amongst the most marked both in this country and in America is the frequent resort to arthrodesis or the fusion of joint surfaces. In the children's hospitals in England before the war the stabilization of joints was not such a common practice as it is to-day. True, the shoulder was sometimes stabilized when the deltoid was paralysed; the spine by an Albee graft for tuberculosis; whilst arthrectomy and excision of the knee in children had been practised but had fallen rather into disrepute. In the adult the joint most often fused was the knee. The surgery of the foot, on the other hand, was largely a matter of tendon transplantation, sometimes with tendon fixation in addition. Small arthrodesing operations—e.g., that of the inner side of the mid-tarsal, the astragalo-scaphoid joint—were sometimes attempted; but this is very different from the stabilizing operations, the mid-tarsal subastragaloid arthrodesis of Dunn in this country and Hoke in America, which we use to-day. Stabilization by wire or tendon ties was practised; indeed, when Mr. Openshaw delivered his Presidential Address, he told us that he frequently wired the spinous processes of the lumbar vertebræ to gain stability of the lumbar spine after crush fractures. Stabilization of the acromioclavicular joint and even of the sternoclavicular was practised by the insertion of a tie wire.

I paid a short visit to the clinics of the Atlantic seaboard of America in May of this year, and found that their problems are much the same as ours, and that they, like us, are attempting to solve certain of them by a more frequent resort to joint stabilization. As will be referred to later, mid-tarsal subastragaloid fusion of the foot is now common practice in both countries, and so frequently is this procedure called for that we are forced to wonder how we got on without it.

When discussing arthrodesis of the hip, I shall compare the results with those obtained by reconstruction, either by Whitman's method, or the more simple attack which we now practise. But arthrodesis of the hip has a definite place in surgery. It is a modern method, and certainly was practised little, if at all, in this country in the pre-war period.

Arthrodesis is a destructive operation; the joint as a joint is destroyed, but it is in most instances preferable to amputation, which may be the only alternative, and by arthrodesis the disease may be cured or the symptoms

abolished. I would instance the mechanical arthritis following an old mal-united fracture-dislocation of the ankle. If we grant that the lapse of time since the accident and the degree of joint change prevents a reconstruction, then a stable, painless, fixed ankle is certainly preferable to amputation, and arthrodesis becomes the operation of choice.

INDICATIONS AND CONTRA-INDICATIONS.

For the purposes of discussion, it is necessary to classify, in some rough way, the indications for arthrodesis; and, as I see them, they are: (1) Pain; and (2) Loss of function, with or without deformity. The pain and loss of function result most often from:—

a. Arthritis—whether infective, toxic, or metabolic. Under this heading we include tuberculosis, and in considering the value of arthrodesing operations in the treatment of joint tuberculosis we shall, I imagine, meet with a marked divergence of opinion.

b. Trauma, particularly in fractures involving joint surfaces and fracture-dislocations in the lower limb. I shall refer particularly to ankle fractures, fractures of the os calcis, and tarsal fractures in general; but there are other minor fractures—e.g., a chip from a phalanx causing a crippling arthritis of an interphalangeal joint—which are well treated by joint fusion.

c. Paralysis, usually resulting from anterior poliomyelitis, but sometimes also from peripheral nerve injury. Those of us who were interested in this subject during the war and in the immediate post-war period will remember being called upon to arthrodese the interphalangeal joint of the great toe following an injury to the sciatic nerve. Fixed flexion deformity of this joint was not infrequently the one symptom which distressed the patient following an imperfect recovery of the nerve. The treatment of paralytic scoliosis by spinal fusion, which is on its trial, also calls for comment.

As regards contra-indications, the one most often met with is fixation or loss of control of a neighbouring or corresponding joint. The most obvious example is the fixed knee, with a painful hip on the same side. A fixed knee with a fixed hip is a disabling deformity, and some other method of relieving the pain in the hip must be sought for.

The influence of the age of the patient as a contra-indication is of interest. I shall suggest that fusion of the knee in tuberculosis of the joint is a reasonable procedure in children, and I do not believe that age plays the part it is supposed to as a contra-indication to joint fusion.

THE QUESTION OF TUBERCULOSIS.

The whole question of the treatment of joint tuberculosis by operation must come under review. It has been the practice to treat all joint tubercle in children by conservative means, and only to resort to operation in the adult. We have believed that the results were good; we have seen the patients lying on frames and in splints in perfectly equipped country hospitals, apparently doing well—the hips held abducted, flexion deformity prevented, the knees kept in good position. and no equinus deformity in the feet. Everything is satisfactory. So far, so good. When, however, we come

to analyse a true series of end-results the picture is very different. Let me say at once that in my own experience the end-result of Pott's disease treated by conservative means is satisfactory. Satisfactory, too, is the end-result of tubercle of the small joints, e.g., dactylitis or tuberculous disease of the elbow or tarsus; but when we consider critically the true end-results of tuberculosis of the knee or of the hip we are struck by the fact that many of them are frankly bad. My colleague, George Perkins, in his Robert Jones Prize Essay of the British Orthopædic Association, analysed a series of end-results of hip tubercle. Out of 50 cases, the femoral head was diseased and altered in 41, resulting in fibrous ankylosis, with, sooner or later, adduction deformity. Old cases from any clinic, treated well or ill, show this tendency, so it would seem that we should be wise to consider whether any other method is more encouraging. In other words, when the head is affected, should the hip be arthrodesed, and if so, by what method?

It is common experience that with tubercle, certainly in the active stage, the ordinary intra-articular arthrodesis, removing the cartilage from the head and from the acetabulum, fails to give bone fusion. We are, I take it, all agreed upon this point, and the experience of the American and Continental surgeons is the same as ours. The various methods of extra-articular arthrodesis, as advocated by Hibbs, by Hass of Vienna, and later by the Boston school, do result in hip fusion, the stabilization of the joint by a bone bridge.

If the end-results of tuberculosis of the hip, treated conservatively, are poor, what are we to say of the knee? In our experience at Pyrford, the average stay of a patient with a tuberculous knee is very variable. The disease becomes quiescent with rest, and then relapse follows. It is not necessary to go into details, but we find some children do better lying in bed with a Thomas knee splint, whilst some are more satisfactory, after the acute stage is passed, in a weight-relieving caliper or patten-ended Thomas walking splint. Tuberculosis in the knee in children commences most often as synovial disease, and the bone is directly invaded at a later stage. It is rare for a bone focus to form the starting-point, although this does occur.

A common story is well illustrated by the following case report: A small boy, A. S., was under treatment from June, 1921, to September, 1922, in the country hospital. He was then discharged with the disease quiescent, wearing a caliper and attending the out-patient department at regular intervals for inspection. The knee remained apparently cured throughout 1923, 1924, and 1925, and then in 1926 there was renewed activity, and in the skiagram the bone for the first time showed evidence of involvement (*Figs.* 281, 282). This knee we arthrodesed (*Figs.* 283, 284), the patient's age being 7, and I suggest that in tuberculosis of the knee-joint in children, when the bone is affected, arthrodesis should be considered. It may be that we should go farther and not wait for bone involvement in proved tuberculosis of the knee-joint. I would not have it thought I am advocating wholesale operating in tuberculous joints in children, or that conservative treatment by rest in our country hospitals is a failure; but I do think that there is a type of joint—generally the knee or hip—which fails to respond to conservative methods. We should not be blind partisans of one form of treatment, but keep an open mind, and adopt what we believe to be the appropriate

treatment for each patient. If we do this, we shall find that in many a stage is reached when the fusion of the affected joint will be the best treatment.

FIG. 281.—Knee, proved tuberculous. No bone change yet. Compare with *Fig.* 282.

FIG. 282.—Same case at *Fig.* 281, two years later.

FIG. 283.—Antero-posterior view of case shown in *Figs.* 281, 282, after arthrodesis. The operation has not interfered with the growth discs.

FIG. 284.—Lateral view of the same case, after arthrodesis. The operation has not interfered with the growth discs.

In an old tuberculous hip with deformity and fibrous ankylosis, we prefer to attack the joint itself, and arthrodese in preference to doing an osteotomy, because in our experience the deformity corrected by osteotomy relapses (*Figs.* 285, 286). We have had no trouble from attacking the diseased area, with one exception, that of a girl with a fibrous ankylosis, probably the aftermath of a pyogenic and not a tuberculous arthritis; severe sepsis followed within a few days of the operation, but the wound healed

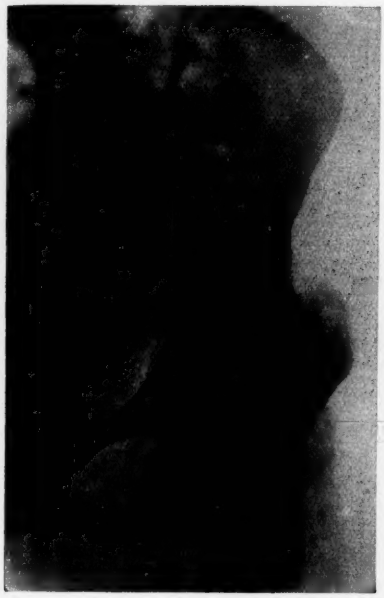


FIG. 285. — Quiescent tuberculous hip. Increasing flexion and adduction deformity. Compare with *Fig.* 286.

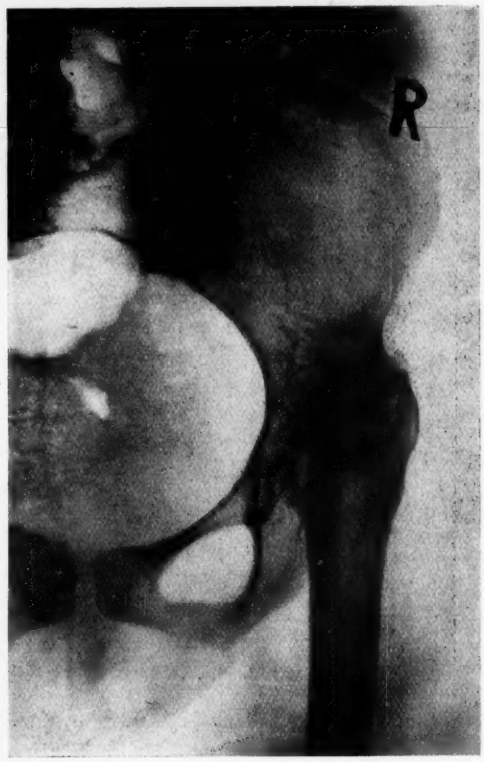


FIG. 286.—Same case as *Fig.* 285, after arthrodesis.

FIG. 287.—Arthrodesis of hip, for arthritis, ? tuberculous, ? pyogenic. (*See* text.)

in a month and firm bony ankylosis resulted (*Fig.* 287). We have met with sinuses after operating on knees, but these have cleared up and given no permanent trouble.

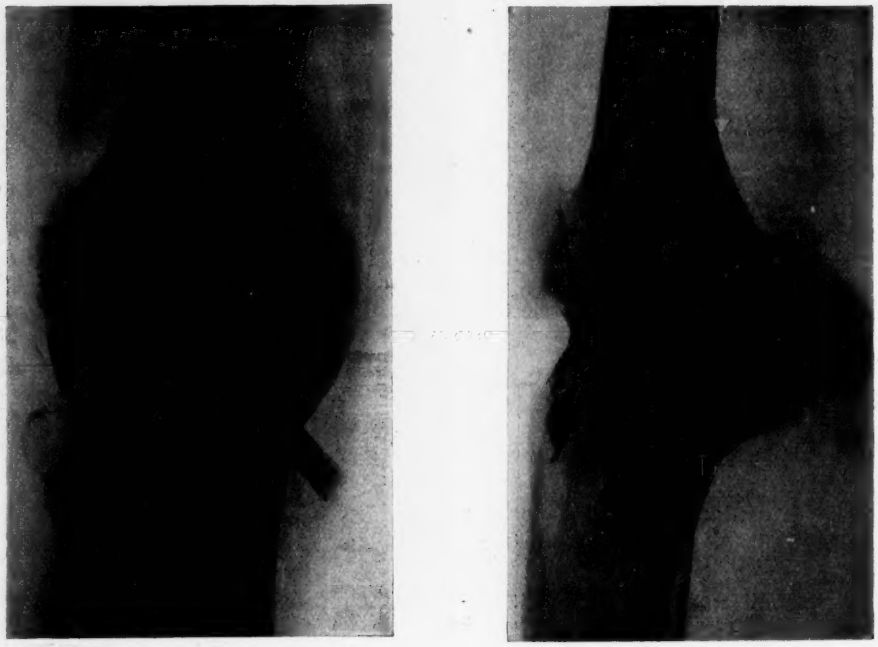
This digression on surgical tuberculosis arose from a consideration of the age of the patient as a usually

accepted contra-indication to arthrodesis, which cannot, in my opinion, be allowed to stand.

TECHNIQUE.

There are, roughly speaking, two different procedures, which are termed the intra- and extra-articular method, of attempting to obtain joint fusion; and I would at once disarm criticism by saying that the so-called extra-articular method is not truly outside the joint, and that the capsule is opened.

In the knee, in the ankle, and in most joints, it suffices to raw the bone-ends and fix them in accurate contact. There are certain technical details which I have found useful; e.g., in attempting to arthrodese the ankle it is wise to dig well up into the cancellous bone of the tibio-fibular mortice after



FIGS. 288, 289.—Bone pegs used to aid approximation, in arthrodesis of the knee.

removal of the cartilage, in order that good contact may be gained for the smaller astragalus. Good contact laterally is gained by dividing one or other malleolus and so getting closer apposition to the side of this bone. When arthrodesing the knee, accurate bone contact may be maintained by using bone pegs (*Figs.* 288, 289), and the patella may be imbedded across the line of the joint. It is not a question of bridging the gap, because there must be no gap. In any event, when operating for a chronic painful arthritis of the knee, it is well to remove the patella, which can serve no useful purpose, and may give rise to trouble later. I have met with one patient who, after a successful arthrodesis in which the patella was left *in situ*, complained of pain in the patello-femoral joint. But it is when we come to the hip that

the intra-articular method is liable to fail, and with tuberculosis for practical purposes always fails. Most of us can recall patients whose hip-joints would demonstrate a perfect result of arthroplasty following an operation in which we have attempted to arthrodese (*Figs.* 290, 291).

FIG. 290.—Intra-articular arthrodesis of the hip for proved tuberculosis. Two months after operation. Compare with *Fig.* 291.

FIG. 291.—Same case as *Fig.* 290, eighteen months after operation. Failure.

The extra-articular arthrodesis of the hip is a recent innovation. The procedure which most appeals to me is that devised and practised by Hibbs, of New York, who may fairly claim to be the pioneer. In April, 1926, he read a paper entitled "A Preliminary Report of Twenty Cases of Hip-joint Tuberculosis treated by an Operation devised to eliminate Motion by Fusing the Joint". From a desultory reading and reports one had the impression that he transplanted the trochanter and fixed it into the ilium above and into the rawed neck of the femur below. We tried this, but found that the trochanter was too short for the

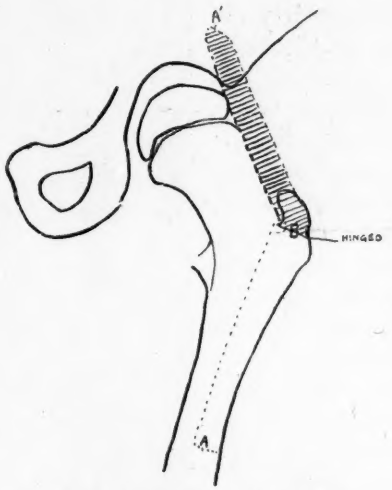


FIG. 292.—Diagram of Hibb's extra-articular arthrodesis of the hip.

purpose. The actual method which he practises (*Fig.* 292), and which most certainly succeeds in fusing the hip, is the transplantation of the anterior two-thirds of the trochanter, together with about two inches of the cortical

bone of the femoral shaft. This bone-graft is pedunculated and left with the upper part of the trochanter attached by periosteum, and the free end—

FIG. 293.—Proved tuberculosis of the right hip, before extra-articular arthrodesis. Compare with *Fig.* 294.

that taken from the femoral shaft—is laid along the superior surface of the neck of the femur bared for its reception, and firmly wedged into a

FIG. 294.—Same case as *Fig.* 293, after extra-articular arthrodesis.

groove cut in the ilium above the acetabular rim. Slight abduction jams the bone-graft firmly into position (*Figs.* 293, 294).

I saw Allison in Boston arthrodese a hip by the extra-articular method, using a free graft taken from the tibia, and he kindly sent me prints of the skiagrams, which illustrate the method he is using (*Figs.* 295, 296). The big tibial graft is supported by small osteoperiosteal or sliver grafts as advocated by the French school. A graft may be turned down from the outer table of the ilium along the neck, to reach the trochanter; but the femoral or tibial graft is as convenient, and is stronger mechanically.

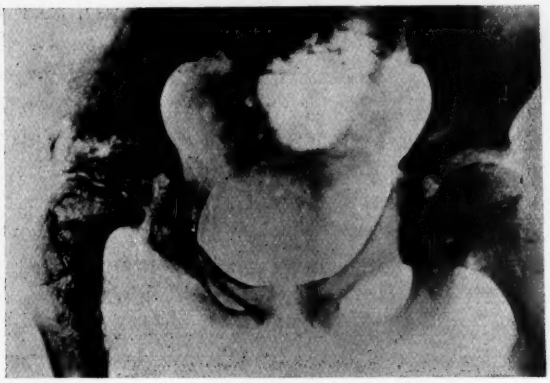


FIG. 295.—Tuberculous hip, before extra-articular arthrodesis. Dr. Allison's case. Compare with *Fig.* 296.

I saw the operation I have described performed by von Lackum in Hibbs' clinic, and Hibbs showed me a large number of patients in his country hospital whose hips he had fused by this method. The hips were firmly fused by bone. X-ray evidence and clinical examination bore this out, and I am convinced that in his hands, at least, the problem of arthrodesing the hip-joint for tuberculosis is solved. Whatever views we may hold as to whether the operation is frequently called for or not, we shall agree that there are occasions when it is necessary to fix the hip.

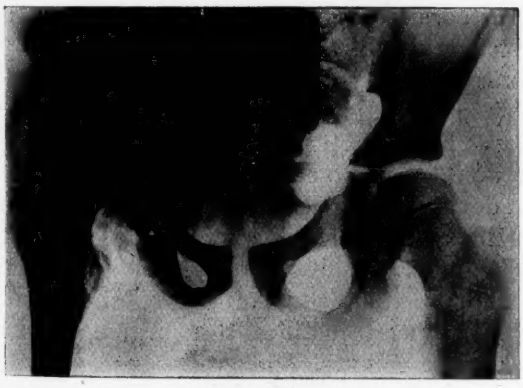


FIG. 296.—Same case as *Fig.* 295, after extra-articular arthrodesis.

In an arthrodesis Hibbs lays great stress on the careful saving of the periosteum, and relies on this structure to form new bone. He peels it off with care, taking perhaps the outer layer of compact bone with it if it does not strip easily. The arthrodesis or fusion of the spine which he practises leaves, when the dissection is complete, a series of spinous processes and laminæ, cleared of periosteum, which periosteum forms a practically unbroken sheet lining the muscles and soft parts which have been retracted.

Bone fusion is proved by clinical examination and by skiagram, and in those patients who have died of intercurrent disease the specimens show the firm bone arch posteriorly, and the fused joints between the articular processes.

PAIN AND DISABILITY FOLLOWING TRAUMA.

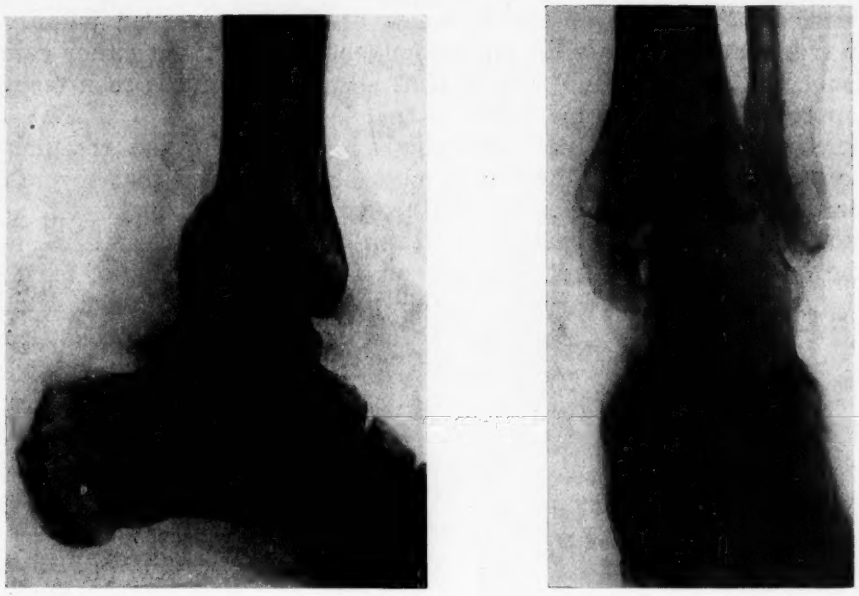
The use of arthrodesis in the treatment of painful joints following fractures or other trauma needs to be emphasized. I am myself convinced that arthrodesis of the ankle is the best procedure to adopt in any old mal-united ankle-joint fracture, when there is evidence of traumatic or mechanical arthritis (*Figs.* 297–300). In a series of patients I have done this operation and the results are good. Pain is relieved, and the function with a fixed ankle, in the right-angled or just above the right-angled position, is excellent. Many of these patients can walk any reasonable distance, and would seem no worse off than before the accident.

The severe disability following a fracture of the os calcis is generally admitted. Treatment by attempted reduction followed by fixation in plaster and relief from weight-bearing for many months has failed to relieve the pain. This is not surprising if, as we believe, the pain is largely due to a mechanical arthritis of the subastragaloid joint. Wilson, of Boston, read a paper in the recent discussion on fractures held under the auspices of the American Medical Association in Washington, advocating immediate arthrodesis of the subastragaloid joint for fracture of the os calcis. He produced statistics of his end-results, proving that his patients of the industrial class got back to full work in a reasonably short space of time, and the results were immeasurably better than by any other treatment. We have done this operation with good result, though only in the late stage; but should not hesitate to carry it out in any recent os calcis fracture involving the joint—and the joint is involved in all crush fractures.

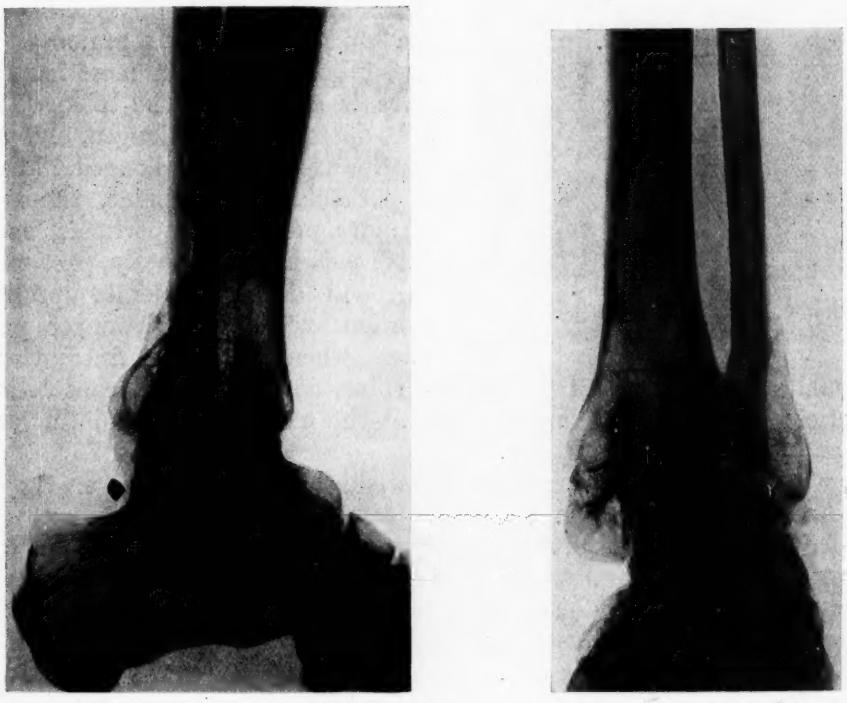
Arthrodesis of the spine—spinal fusion—is practised in America as the treatment for crush fractures of the vertebræ. Osgood and the Boston school are confident that the results are better, and more quickly obtained, than by conservative treatment. In that country, too, where low backache is so common, arthrodesis of the lumbo-sacral joint, and, with some, arthrodesis of the sacro-iliac joint, are becoming popular. Smith-Petersen's approach and technique in operating on the latter joint would seem to ensure fusion of the joint.

In spinal fusion the operation devised by Hibbs is the operation of choice. Anyone who has watched Hibbs arthrodese a spine must, I think, feel, as I did, that the operation is bound to result in solid bony ankylosis. Technically the operation is more difficult than that of Albee, and takes considerably longer, but to my mind the end justifies the means. Three months' rest in bed in a light back-brace follows, after which the patient is allowed up without support.

The size and importance of a joint are not necessarily the only factors which govern our decision. I saw this year a patient with a chip fracture of the phalanx of a ring finger, with mechanical arthritis of the interphalangeal joint. He had been prevented from using the hand by pain for some nine months. Fixation by strapping and a splint had failed to relieve the arthritis. A simple operation, such as most of us use for a hammer-toe, gave him a useful and painless finger which enabled him to hold a golf club in comfort and use the hand freely. The terminal interphalangeal joint was fused in slight flexion, and there was no disability.



FIGS. 297, 298.—Mal-united Pott's fracture, before arthrodesis of the ankle. Lateral and antero-posterior views. Compare with *Figs.* 299, 300.



FIGS. 299, 300.—The same case as *Figs.* 297, 298, after arthrodesis of the ankle.

I have never myself seen the necessity to fix either end of the clavicle for recurrent dislocation of the acromio- or sterno-clavicular joints. The former is a common, the latter an uncommon, accident. In either case the functional utility of the limb is little if at all affected, and is soon recovered with appropriate physical methods.

When considering the part arthrodesis is to play in the treatment of chronic painful arthritis of the hip, it must be emphasized that severe pain, with or without crippling deformity, is the symptom which makes one advise operation. Imagine symptomatic treatment has been tried and has failed, and the question arises—Can operation on the hip offer hope of relief from the pain, and, if so, what operative attack is best suited to the needs of the particular patient and the particular hip?

FIG. 301.—Whitman's reconstruction of the hip for chronic arthritis.

We have attempted to arthrodese the hip-joints in about thirty patients. Pain can be relieved, although the hip does not always arthrodese, for the operation may, and frequently does, result in a short fibrous ankylosis. The method is useful, but there are certain considerations which have made us try out the operation of reconstruction, leaving a movable joint. First, the after-treatment of arthrodesis of the hip is necessarily a prolonged fixation in plaster, and in most hands the spica is applied on the table. Therefore operation is prolonged, and after-fixation very much prolonged. The first is perhaps a small point, the second of more practical importance, because these patients are usually past middle life and do not tolerate prolonged fixation as well as younger people. Then, when the hip is fixed, there is additional strain thrown on the lumbar spine, and it is small consolation to the patient if his painful hip is cured at the expense of a painful lumbar spine and chronic low backache.

Again, both hips are sometimes affected, or a hip and knee on the same side. Arthrodesis of the hip is then out of the question.

I feel, then, that reconstruction of the hip, although still perhaps in the experimental stage, is well worth a trial. We used to practise the operation devised by Whitman (*Figs.* 301, 302), but we now try what is a more simple procedure (*Fig.* 303), and the results are fairly good. The operation is simple, and there is little shock. The after-treatment consists in moderate fixation for a month, and then the patient is allowed up. We insist on frequent manipulation in the direction of extension and abduction, just as

Whitman taught was the correct after-treatment following his reconstruction of the joint.

The treatment of paralytic deformities by joint fusion dates back many years, but the great change which has taken place is in the treatment of the paralytic deformities of the foot. We owe to Dunn in this country the modern operation of mid-tarsal sub-astragaloid arthrodesis—and the American surgeons favour a somewhat similar operation, devised independently about the same time by Hoke. Dunn's method of stabilization of the foot, the employment of which is by no means confined to paralytic deformity, has solved many problems which were before incapable of solution. Dunn's operation has stood the test of time and gives a good functional foot. In many paralytic deformities of the foot it must be combined with tendon transplantation, if we are to avoid recurrence of deformity by unbalanced muscular action.

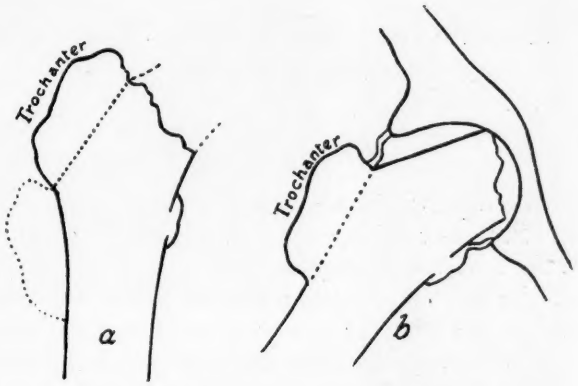


FIG. 302.—Diagram of Whitman's reconstruction operation on the hip-joint. *a*, Showing complete loss of femoral neck after fracture. *b*, Shows reconstructed neck and area obtained from removal and transplantation of trochanter. (*From 'Annals of Surgery.'*)

Arthrodesis of the shoulder, less often called for, yields good results in carefully selected cases.

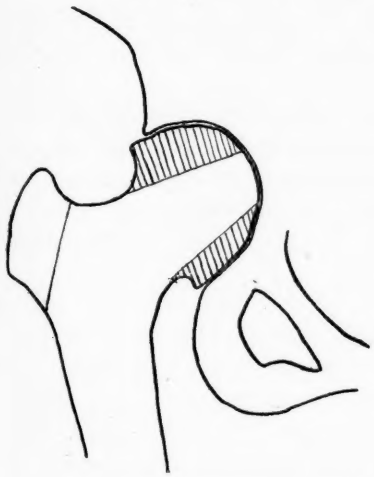


FIG. 303.—Diagram of the 'remodelling of the head' operation for chronic arthritis of the hip-joint.

I have attempted to call attention to the important position which arthrodesis occupies in modern orthopædic surgery, and to suggest that its sphere of usefulness is wider than we have believed in the past. Whilst its uses in the treatment of surgical tuberculosis during the active stage are to be carefully weighed and considered, I feel that in certain directions, notably in the treatment of mechanical arthritis, we can with advantage practise it more often. May I say again that for mal-united Pott's fractures and for fractures of the os calcis I think that arthrodesis should be resorted to much more frequently than has been our custom. Finally, for many conditions we have here a method which we can employ with the certainty of success in attempting to solve that all-important problem—the relief of pain.

TREATMENT OF ANKLE AND LEG FRACTURES BY THE 'DELBET' AMBULATORY PLASTER SPLINT.

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The following ambulatory treatment is based on that elaborated and described by Professor Pierre Delbet, of the Hôpital Cochin, Paris. This method of treatment was introduced to the writer in January, 1923 (when House Surgeon at the Royal Northern Hospital, London), by Mr. Gwynne Williams, under whose direction he was permitted to treat his first cases.

The method differs from others in the following particulars :—

1. The patient is made to walk within one, two, or at most three weeks from the date of accident, bearing full weight on the injured limb.

2. From commencement of walking he actively moves ankle- and knee-joints, thus enjoying the most efficient form of massage—namely, natural function; this prevents that long-persisting stiffness and swelling of the foot which so loudly advertise the limitations of the usual methods of treatment.

3. He is able to return to ordinary forms of work in from four to six weeks after the date of accident if he wishes to do so, walking in his splint, without being encumbered by the use of crutches or walking-sticks.

4. From eight to ten weeks after the date of the accident the plaster splint is removed and all form of treatment ceases, except that the boot is wedged on the inner side.

The method has been found successful in the following types of cases :—

Ankle Fractures.—(*a*) Abduction and adduction fractures with one or both malleoli detached, and with lateral displacement of the astragalus. (*b*) Malleolar fractures with anterior or posterior displacement of the astragalus, and with a detached wedge off the front or back of the tibia, the fragment not being much displaced.

Leg Fractures.—

1. *Closed Fractures.*—(*a*) Fracture of the tibia alone. (*b*) The 'torsion' variety, an oblique or spiral fracture in the lower third of the tibia and upper end of the fibula, when there is not much over-riding or angulation of the fragments. In these cases the bones frequently lie in close apposition and parallel with each other, while shortening does not exceed a quarter to half an inch. (*c*) Transverse fracture of both bones in the lower half, with or without comminution, as occurs when a cart-wheel passes over the leg above the ankle. To avoid the disabling deformity of posterior bowing, one should deliberately aim at producing a slight degree of anterior angulation by placing a firm wad (bandage roll) under the plaster before it sets, opposite the line of fracture. (*d*) Some cases of fracture in the upper half of the leg; in these the Delbet plaster as described below is useless, but at the suggestion

of Mr. Gwynne Williams the writer has extended the plaster up to the mid

FIG. 304.

FIGS. 304, 305.—To show application of extended Delbet splint.

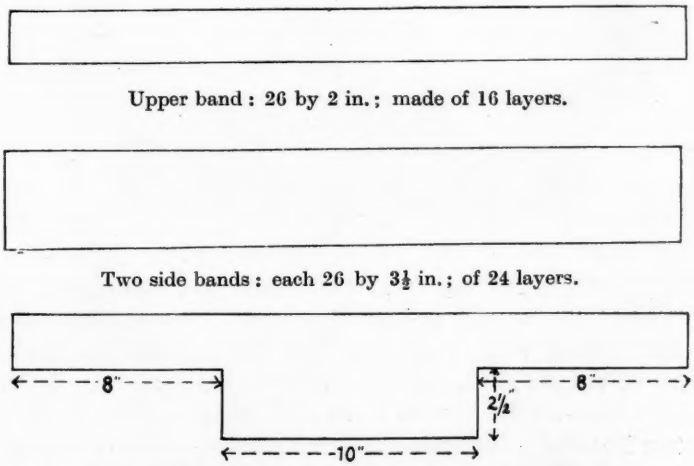
FIG. 305.

thigh, and in the two cases in which this was tried the results were very satisfactory (*see Figs.* 304, 305).

2. *Open Fractures.*—When the wound has healed, provided that good alinement of the fragments has been maintained.

THE 'DELBET' PLASTER.

The plaster is applied immediately after manipulation has been carried out as described below, while the patient is still under the anæsthetic. The splint consists of four pieces, made of book



Upper band: 26 by 2 in.; made of 16 layers.

Two side bands: each 26 by 3½ in.; of 24 layers.

Lower band: 26 by 2 in., with heel-piece; of 16 layers.

FIG. 306.—Diagram to show the composition of the Delbet splint.

muslin (mesh 42), cut to pattern as shown in *Fig.* 306. The measurements are varied as required for adaptation to small or large legs.

A board is placed under the leg to make a firm even surface. The foot being held by the toes in an inverted position by an assistant, the leg is marked as follows: (1) A transverse line is drawn across the front and sides of the leg at a level just below the prominence of the tibial tubercle. (2) A line is drawn longitudinally up each side of the leg from the anterior border of the corresponding malleolus to the transverse line above. The transverse line marks the upper limit of the upper band when wound round the leg, and the longitudinal lines mark the anterior border of each side band when applied; thus the lateral band will lie on a more posterior plane than will the mesial band (*Fig.* 307). If the leg is very hairy it may be shaved; this is not essential. The leg and foot are well greased with vaseline. Strips of

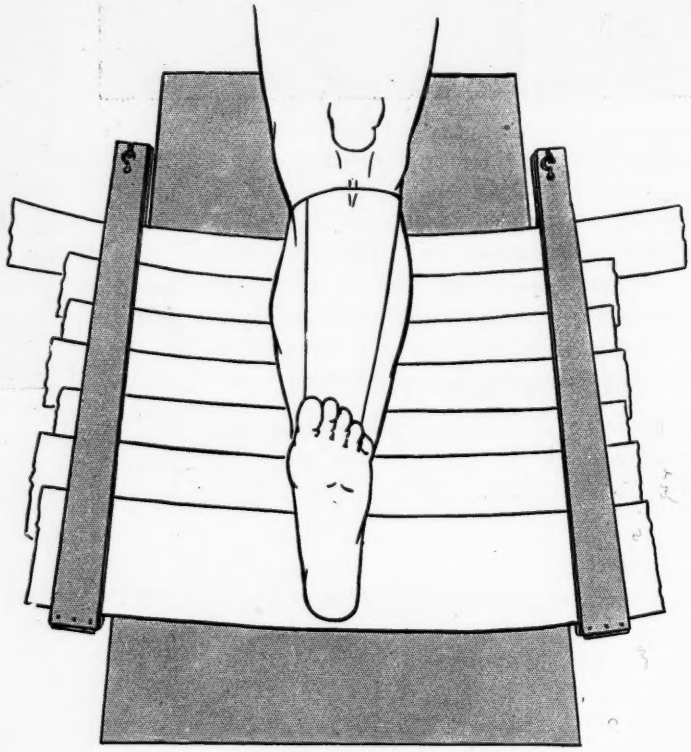


FIG. 307.

calico bandage (4-in.), cut out with a curve and arranged in imbricated fashion, have been previously prepared and secured in two wooden clamps (*Fig.* 307). Later they will be used to bind the wet plaster bandages tightly on the leg and so ensure a close fit. The clamped strips are now laid flat on the board under the leg, to extend from heel to knee (*Fig.* 307).

Mixing the Plaster.—One pint each of plaster-of-Paris and of cold water are usually sufficient; in warm weather 24 oz. of water are used. The plaster should be purchased in sealed tins, the lid being resealed by adhesive strapping after use, to keep the contents air-tight (the writer uses the plaster supplied in 7-lb. tins by Messrs. Allen & Hanburys). It is not advisable to use agents for hastening the setting of the plaster, such as warm water or

the addition of salt or alum; this introduces a variable factor which is not only unnecessary but may cause setting before the operator has time nicely to adjust the bandages. A large enamel basin is used for mixing; the plaster is quickly sprinkled into the water, and stirring is not begun until all the plaster has been put in and is completely wetted. This ensures a thin, even, creamy mixture without lumps. The bandages are all put into the mixture together, each piece in succession being thoroughly soaked.

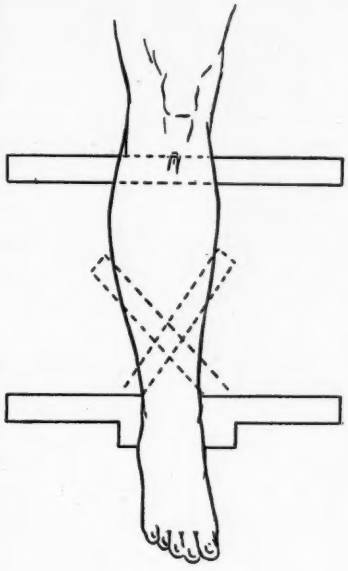


FIG. 308.

Application of the Plaster Bandages (*Figs.* 308, 309).—One assistant is needed, who stands at the opposite side of the bed, and should be conversant with the method.

1. The top band is laid under the leg, its upper border coinciding with the marked transverse line, with protruding ends of equal length.

2. The lower band is then laid transversely in position, so that the lower border of the central heel-piece lies just short of the flat plantar surface of the heel, and with the heel placed excentric, allowing more turn-up on the inner side of the ankle, where the malleolus reaches farther forward than on the outer side.

3. Each side band is now applied as follows, the one on the assistant's side of the leg being placed first (*Fig.* 309): The band is placed so that the knee end reaches the transverse line on the leg, and the anterior (uppermost) border coincides with the marked longitudinal line. The assistant presses the knee end against the leg with his thumb; the band is now doubled back on itself below, the doubled portion extending about three-quarters of the way up the leg again, and the folded border reaches downwards to just short of the plantar heel surface. The assistant holds the lower end to the leg just above the ankle with the other thumb; closing his grip above and below he now rotates the leg towards the operator, while the latter adapts the posterior part of the band to the leg. The other side band is applied in a similar manner, the assistant holding it to the leg by closing the grip of each hand, and again rotating for posterior adaptation.

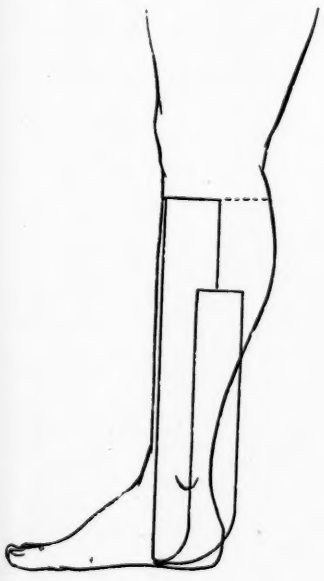


FIG. 309.

4. The upper band is then bound tightly round the top of the leg outside the side bands; this is best effected by the assistant maintaining a pull on one end while the other end is pulled over and across and tucked

in flat behind, the side bands still being held in position by the free hand of each worker.

5. The lower band is applied in the following manner: Each lower corner of the heel-piece, and the corresponding point of its upper border, is grasped between finger and thumb of both the operator and his assistant on either side. The hands are then brought forward, and thus the heel and malleoli are encased in the plaster. The assistant then stands at the foot of the bed, or preferably kneels, and with hands placed along each side of the heel and ankle presses firmly on the plaster, at the same time inverting the heel and external malleolus. Meanwhile the operator crosses the two ends of the lower band over the leg, leaving room for play of the tibialis anticus tendon below the crossing when the patient commences walking. A little plaster cream is then rubbed over the various joins.

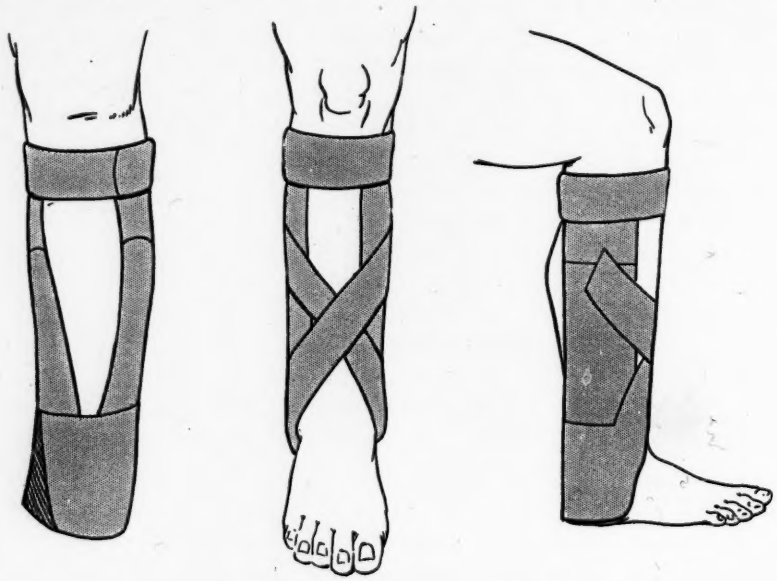


FIG. 310.—Showing the leg after removal of the calico.

6. Lastly, the clamps are opened and the calico strips (*Fig.* 307) bound over the plaster in 'many-tail' fashion; this should be done tightly, beginning below and on the inner side, as the inner band has a tendency to slip backwards. The whole is 'tied' by knotting the uppermost strip over the interval between the two bones, thus avoiding a pressure sore later under the knot. The foot and ankle are again compressed between the two hands and inverted as before, and held thus until the plaster sets hard, which will be in about ten minutes from the time of mixing.

Sandbags are stacked on either side of the leg, interlocked by a roller towel, the weight preventing the patient from moving the limb while coming round from the anæsthetic. The leg is left so for two hours, after which it is placed on a pillow. The calico strips are removed on the following day and the plaster is dated. (*Fig.* 310.)

It must be noted that no moulding should be done after the plaster

has begun to set, as this causes it to crack. When the plaster is quite dry and of stony hardness, which will be after one or two days, the ankle is X-rayed again, and if the displacement of the astragalus has not been *completely* reduced the plaster is removed, another general anæsthetic administered, and the persisting displacement corrected.

The above description may seem tedious and superfluous in detail, but to obtain success by this method of treatment a solid accurately-fitting plaster is essential; one must have a methodical procedure to work on, and the laborious experience of over two hundred 'efforts' has suggested to the writer little manœuvres which both save time and make for success.

Successive plasters are put on the same case as required in exactly the same way, though the anæsthetic and manipulation are not repeated unless the first attempt at reduction has failed. The indication for renewal is looseness of the plaster owing to the gradual subsidence of œdema; the average number of plasters for the whole period of treatment in cases of ankle fracture is two or three. All form of treatment ceases in from eight to ten weeks from the date of accident, when the last plaster is removed, the patient at this stage having been walking for the several preceding weeks without stick or aid of any kind.

It will be noticed that the plaster is applied directly on the skin surface; this leads to no ill-effects *per se*, and the absence of any form of lining material makes easier the early detection of the presence and extent of pressure sores later. However, if abrasions or blisters are present, a small piece of double thickness of gauze wetted with flavine is placed over them before the plaster is applied.

ANKLE FRACTURES.

The following is a detailed account of the method of treatment used by the writer in cases of recent ankle fracture:—

1. The patient is put to bed with the leg—which is temporarily controlled in a box splint—raised high on pillows, so that the ankle is higher than the knee, and the knee higher than the hip; this partially reduces the swelling and alleviates pain. A flavine dressing for abrasions and blisters, and a cooling lotion, are applied if necessary.

2. The ankle is X-rayed as early as possible, the splint being removed for the purpose: two views are taken. It is well to emphasize that a 'dead true' antero-posterior view is essential, especially in those cases in which there is only a slight lateral displacement or eversion of the astragalus, as such slight displacements tend to be completely missed even when shown by the skiagram, and so remain uncorrected with a resulting future disability.

3. A general anæsthetic is given in every case, and complete relaxation obtained where the skiagram shows any displacement, unless the general condition of the patient forbids. This may seem unnecessary in cases presenting only slight displacement, but in the experience of the writer it is just these cases which offer most difficulty in reduction. Adduction fractures are more easily reduced, and the procedure can often be accomplished without any anæsthetic. It is interesting to note that in them no ligaments are ruptured

(other than the joint capsule). However, it is safer to adopt the rule that a general anæsthetic should be given in all cases.

Reduction.—It is not necessary to flex the knee in order to reduce posterior dislocations if full anæsthesia is obtained, the weight of the limb alone being almost sufficient to effect reduction if the foot is held up by the heel.

To correct lateral displacement, in the case of the right ankle, the leg is grasped by the left hand just above the ankle, preferably with the 'heel' of the hand and ball of the thumb pressed against the mesial border of the tibia; the heel of the foot is grasped in the right hand so that the 'heel' of the hand is pressed over the external malleolus (*Fig.* 311); firm steady pressure is now exerted in opposite directions by the two hands, the right dorsiflexing at the ankle-joint while maintaining inward pressure over the external malleolus. In the case of the left ankle the 'holds' are reversed. Rough handling, as by bruising the tissues in a vicious finger-grip, is to be avoided; this only increases the injury to the soft tissues, with resulting increase in swelling which holds the plaster splint farther off the bones, lessening its retentive effect.

FIG. 311.—To illustrate the correction of lateral displacement.

So important is it to obtain complete replacement of the outward astragalus that one may adopt the working rule that it is impossible to over-correct it; this is not strictly true, but the point is stressed because on several occasions after he had used force almost amounting to violence the writer has been disappointed to find a persisting slight outward displacement, as shown by X rays. Also it must be remembered that the clinical appearance of a swollen ankle is no certain guide to the position of the underlying joint bones; radiography offers the only proof.

When should reduction be effected? Generally speaking within forty-eight hours from the time of accident if possible; greater hurry is not essential, although often desirable. In cases, however, where swelling and blebs are very marked, and displacement is not extreme with skin stretched tight over the fragments, it is an advantage to leave the patient with his foot well raised and the blisters dressed for three or even four days before reducing, thus allowing the swelling to subside partially before putting the leg and foot in plaster as described above.

Pressure Sores.—Sores caused by chafing of the plaster do occur, the common sites being at the anterior corners of the lateral bands and at the edges of the upper band. The sores are generally quite superficial, and the only treatment required is to cut away the offending edge of plaster, and make the patient rest more with the leg elevated on a chair. Occasionally deeper

sores occur which necessitate temporary confinement to bed and free paring of the plaster to allow for dressing; such sores may delay walking for one or even two weeks, but are certainly not of sufficient gravity or of such frequent occurrence as to constitute a serious objection to the method, compared with its overwhelming advantages to the patient. An avoidable pressure sore is one due to pressure of the knot tied in the uppermost calico strip causing an indentation in the plaster if the knot is placed over the front of the tibia: it should be over the interval between the two bones.

Walking.—Professor Delbet,[1] in his description of this method, advocated walking within a day or two of the application of the plaster. While the writer fully agrees with such early walking in the slighter cases not showing any displacement, he thinks there is a risk of redisplacement occurring if weight-bearing is allowed in the more severe cases at such an early date, as the large amount of œdema around the ankle so often present in these cases holds the plaster off the external malleolus, thereby permitting movement of the latter under stress; for the acting principle of the plaster is that it prevents lateral movement of the parts controlled by it, and not that it transmits the body weight from the malleoli to the upper end of the tibia, as was claimed by Professor Delbet. Therefore, at the commencement of treatment the first plaster is used merely as a retentive splint, and is renewed when swelling has subsided sufficiently to make it loose, usually between the first and second weeks. It may be mentioned here that others who have adopted this method put the foot and leg up in a complete plaster cast after manipulation; this is removed in about two weeks and replaced by a Delbet plaster. There is no essential difference between the two procedures, each splint being equally retentive if properly applied.

When the second Delbet plaster is thoroughly dry and hard the patient is made to walk. This is sometimes a laborious task for the surgeon, especially in the 'compensation' or 'dole' type of patient, and requires much patience and firmness; but it is often surprising to find how some patients with more spirit will walk tolerably well from the start. At the first lesson it will be well for the surgeon to ignore completely the protestations of pain and inability to stand made by a 'flabby' patient; the latter must be convinced that his injured limb can bear his weight by being made to stand firmly on it from the outset.

The patient is first allowed to swing his legs over the side of the bed for a few minutes, after which he is made to stand upright, with feet a little apart and toes pointing directly forwards facing the surgeon, who holds his hands; he now bends both knees several times while keeping his heels on the ground, and so actively dorsiflexes the ankle-joint from the very beginning of treatment. The patient then walks, taking small steps, and bringing each foot in front of the other at each step, his only support being 'holding hands'.

After he has been thoroughly convinced that he *can* walk, he is given sticks with rubber ferrules and encouraged to get about as much as possible. The objection to allowing a patient to walk with crutches is that he avoids putting any weight on the injured limb and does not move his ankle-joint, thereby missing the whole principle of the treatment. The most accurate estimate of progress is by making him walk 'holding hands', by which

means he must bear his own weight. Enthusiastic patients will find that they can dispense with both sticks in from one to two weeks. In the early stage walking increases the swelling, which may lead to pressure sores from the skin bulging over the plaster edges; this can be relieved by making the patient sit with the leg raised on a high chair whenever he is not actually walking.

Return to work is permitted, in the splint, as soon as the patient can walk with confidence; this period will vary with the mentality of the individual and with his particular kind of work; an occupation which entails ladder-climbing will be obviously unsuitable. The writer has had patients who have, in their plaster, knelt to do housework, stood all day at the wash-tub, walked over seven miles (a leg fracture), while many have been able to get about on buses and trams, thus resuming an active life in from three to four weeks after the injury.

Results.—Manipulation being the method of choice in the great majority of cases of ankle fracture, and retention by means of plaster-of-Paris being generally conceded the most reliable form of splinting, it remains to determine which method can get the patient back at work and provide him with permanent good function in the shortest space of time. The writer's series of cases is too small to justify any claim regarding his results as compared with those achieved by other methods; but a brief survey of a few collected facts will, he hopes, warrant the conclusion that the Delbet plaster offers promise of a definite advance in the treatment of this difficult type of fracture.

Of the 24 cases of recent ankle fractures in this series there was no apparent displacement of the astragalus in 5. Of the remaining 19 cases a general anæsthetic was contra-indicated in 3. The following figures are averages taken over the 24 cases: (1) Date of commencement of walking, from day of accident, 14 days. (2) Date of removal of last plaster, and cessation of all treatment, from day of accident, 52·2 days. (3) Date after accident on which patient dispensed with use of a stick (ascertained in 21 cases only), 35 days.

Statistics in fracture cases are a doubtful source of information, based as they frequently are on a circularized questionnaire addressed to the patients. It is particularly difficult to convince a work-shy patient that he is fit to resume work, when a weekly visit to his panel doctor, on a plea of persistent pain or swelling, will provide him with the desired certificate of disability. One can only eliminate any tangible cause by X-ray and clinical examination, and then compare him with others who have suffered a similar or a more severe injury, but whose interests have been best served by an early return to their occupation. Therefore it would seem of much more value to quote X-ray and clinical findings at the end of the period of treatment, and again at a more remote date.

Another confusing factor to be considered when working out a new method of treatment is that failures during the experimental stage may be due to ignorance on the part of the worker, or to his method. In this connection the writer may state that of his own failures—5 out of 24 cases treated with the Delbet plaster—incomplete reduction at the outset (although a general anæsthetic was considered inadvisable in 3) was responsible for 4. The fifth case is an instance of failure of the method, the only apparent

excuse being that the patient, a woman of rather heavy build, was permitted to walk on the sixth day, when œdema around the ankle was still marked.

It will be more instructive and convincing to present a few cases, with X-ray plates and full details of treatment, as showing some results that have been obtained by this method.

CASE REPORTS.

Case 1.—**Severe abduction fracture of the ankle, Dupuytren type (*Figs.* 312–315).**

S., age 22, picture framer. On *Jan.* 17, 1926, had a toboggan accident, fracturing the right ankle.

FIG. 312.
Case 1. Jan. 18, 1926.

FIG. 313.
Case 1. Jan. 18, 1926.

FIG. 314.
Case 1. July 13, 1927.

Jan. 18: Marked swelling and deformity of the right ankle, large blisters, lower end of tibial shaft almost through skin. Manipulation under general anæsthetic; 1st Delbet plaster.

Jan. 25: 2nd Delbet (did not set).

Jan. 26: 3rd Delbet.

Feb. 1: Patient walked.

Feb. 2: 4th Delbet; Dispensed with sticks.

Feb. 6: Walking almost naturally.

Feb. 14: Plaster removed; two deep pressure sores, one over internal malleolus; put to bed.

Feb. 24: To sit up with leg raised.

Mar. 3: 5th Delbet.

Mar. 5: Walks with barely perceptible limping.

Mar. 6: Discharged.

Mar. 24: Plaster removed. All treatment ceased, i.e., 66 days after accident. Has been at work since discharge and leading normally active life, riding on buses and trams; no limping during past week. All movements of ankle free, including full dorsiflexion. Skiagram showed good position.

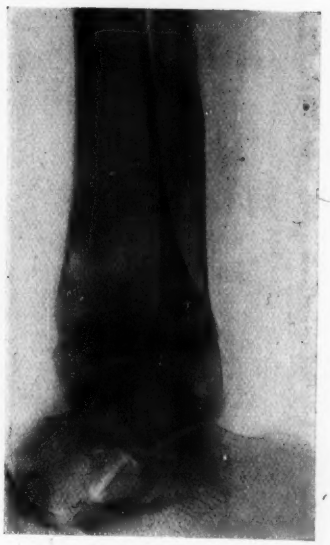


FIG. 315.
Case 1. July 14, 1927.

LATE RESULT.—July, 1927: Has had no disability whatever since last seen. No deformity, pain, or swelling. All movements of foot and ankle equal to those of the other side. Skiagram.

Case 2.—**Abduction fracture of the ankle with complete posterior dislocation** (*Figs.* 316–318).

P., age 65, retired station-master. On *June* 29, 1923, was knocked down by motor van, the wheel of which passed over the left ankle. Manipulation was done under a general anæsthetic, and a Delbet plaster applied.

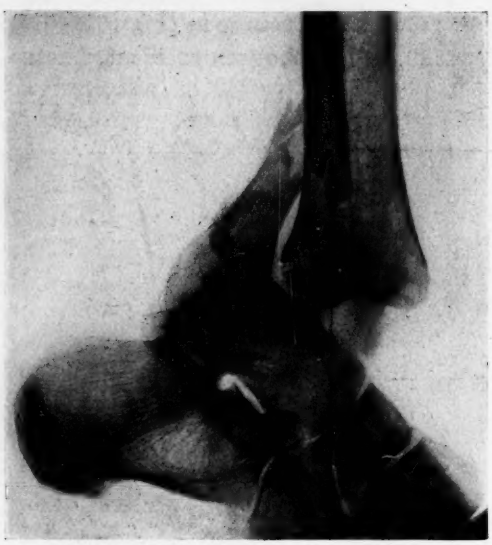


FIG. 316.—*Case* 2. June 29, 1923.

July 5: Plaster removed owing to pressure sore over internal malleolus.

July 13: 2nd Delbet plaster.

July 21: Has been walking several days. Discharged.

July 30: 3rd Delbet plaster.

Aug. 29: Plaster removed. All treatment ceased, i.e., 61 days after accident. Walks well. On arrival home walked upstairs alone, without a stick. Did not require stick after this date, although used one when out because he was nervous.

LATE RESULT.—Seen in August, 1927, patient stated that from one month after removal of plaster he had no limp, and the left ankle was as free as before the accident. Has suffered no disability in any way since. Examination: No limp, very slight eversion left foot. All movements of foot and ankle equal to those of the other side, including dorsiflexion to beyond a right angle. Skiagram.

FIG. 317.
Case 2. Aug. 11, 1927.

FIG. 318.
Case 2. Aug. 11, 1927.

Case 4. — **Abduction fracture of the ankle with outward and backward displacement, posterior wedge off tibia (*Figs.* 319–322).**

FIG. 319.
Case 4. Sept. 9, 1926.

FIG. 320.
Case 4. Sept. 9, 1926.

FIG. 321.
Case 4. July 19, 1927.

Mrs. G., age 43, housewife. On *Sept.* 9, 1926, tripped when getting off tram, fracturing right ankle.

Sept. 10: Manipulation under general anæsthetic. Complete plaster cast.

Sept. 24: Plaster removed; skiagram shows persistent slight outward displacement. Manipulation under general anæsthetic. 1st Delbet plaster.

Sept. 29: 2nd Delbet.

Oct. 1: Walked well.

Oct. 2: Walked without sticks.

Oct. 12: 3rd Delbet.

Oct. 28: Plaster removed. All treatment ceased, i.e., 49 days after accident. Skiagram.

Nov. 4: Walks with slight limp, rather nervous. No deformity, some œdema. All movements of right foot and ankle equal to those of the left side, but dorsiflexion only to a right angle.

LATE RESULT.—In July, 1927, there was no disability in any way, no pain, no swelling, no deformity.

FIG. 322.
Case 4. July 19, 1927.

LEG FRACTURES.

Contra-indications.—(1) Fractures involving the upper joint surface of the tibia. (2) When there is marked tilting of pointed fragments which would lead one to suppose that the periosteum has been 'button-holed' by one of them, some form of continuous traction on the lower fragment is essential; this may be effected by a metal pin driven through the os calcis, or by an adhesive apparatus on the foot, according to the temperament of the surgeon. In the writer's experience, temporary traction under a general anæsthetic,

even by hanging a 40-lb. weight on the foot for half an hour, has not been successful in reducing such displacements. If used in the later stage of treatment in these cases, the Delbet plaster will enable the patient to get about at an early date and so considerably shorten convalescence.

It is common knowledge that weight-bearing through a fractured limb stimulates the early formation of firm callus; this fact is well illustrated in a small series of 14 cases of leg fracture: in these the average period of treatment was only 62 days, after which no support was necessary, other than the use of a stick in some cases. The average age of these patients was 46 years, and shortening did not exceed $\frac{3}{4}$ in., except in one case which is now recognized as being an unsuitable type of fracture for this form of treatment in the early stage; this patient had $\frac{7}{8}$ in. shortening.

That absolute anatomical reposition of the fragments is not essential to the recovery of perfect function is borne out by experience (*see Case* 9). Provided that good alinement is restored, through which weight is transmitted vertically from the joint above to the one below the fracture, no disability need be feared.

The Delbet plaster is applied in cases of leg fracture in exactly the same way as has been described above; the method described by Professor Delbet of obtaining traction during the application of the plaster by attaching a heavy weight to a tape 'stirrup' sewn around the ankle, has not proved very effective in the writer's hands.

When angulation or some other form of displacement makes manipulation necessary, a general anæsthetic is given and the plaster put on after the deformity has been corrected.

FIG. 323.
Case 7. April 10, 1923.

FIG. 324.
Case 7. Aug. 16, 1927.

CASE REPORTS.

Case 7.—**Leg fracture torsion variety (*Figs.* 323, 324).**

T., age 54, salesman. On *April* 10, 1923, fell down steps, fracture right leg, lower third tibia, upper fourth fibula. No displacement.

April 12: 1st Delbet applied, no anæsthetic.

April 15: Walking with sticks.

April 16: 2nd Delbet plaster.

April 21: Walking better.

April 26: 3rd Delbet plaster.

April 28: Patient discharged. Walking.

June 13: Plaster removed. Walks well; $\frac{1}{4}$-inch shortening.

LATE RESULT.—Seen in August, 1927, patient had no limp, no deformity, ¼-in. shortening. Natural gait. Has suffered no disability. States that he used a stick for one month after plaster was removed. Got job as 'traveller' at end of July, 1923, and was walking about from 9 a.m. till 5 p.m. daily.

Case 9.—**Leg fracture. Anatomical reposition not effected: no functional disability as a result (*Figs.* 325–328).**

Mrs. M., age 42, housewife. On *July* 24, 1926, slipped on ground; closed fracture right leg, lower half tibia, lower fourth fibula. Forward displacement lower fragment, 1¼ in. shortening. Two attempts to reduce displacement by hanging a 30-lb. weight on foot for half an hour failed (without anæsthetic).

Aug. 6: Continuous extension made on the lower fragment by attaching a 9-lb. weight to a plaster-of-Paris sock.

Aug. 10: Weight increased to 12 lb.

Aug. 19: Plaster sock removed, deep pressure sores over dorsum, ankle, and on heel; ¼ in. shortening. Delbet plaster applied.

Aug. 21: Walked a little.

Aug. 25: Can walk without sticks.

Sept. 9: Plaster removed on account of heel sore.

Dec. 21: Heel sore not yet healed. Up but not walking. Dorsiflexion at ankle limited.

Jan. 6, 1927: Sore healed. Cannot keep heel on ground when walking.

Jan. 13: No progress. To wear flat shoes.

FIG. 325.
Case 9. July 30, 1926.

FIG. 326.
Case 9. July 30, 1926.

FIG. 327.
Case 9. July 21, 1927.

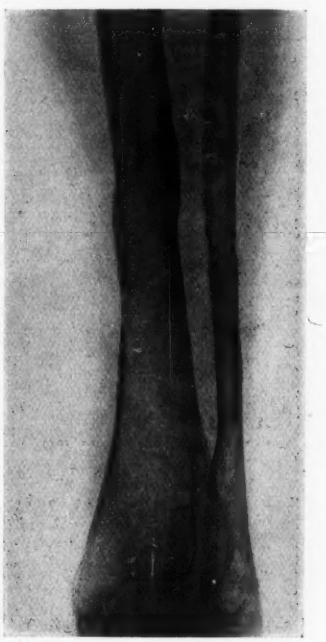


FIG. 328.
Case 9. July 21, 1927.

LATE RESULT.—Seen on July 21, 1927, patient stated that she used two sticks till May, 1927; since then no incapacity at all. On examination she was found to walk without limp in shoes; slight limp without shoes. Slight irregularity over front of tibia; ½-in. shortening. Dorsiflexion at ankle just short of sound side.

FIG. 329.
Case 11. Aug. 18, 1926.

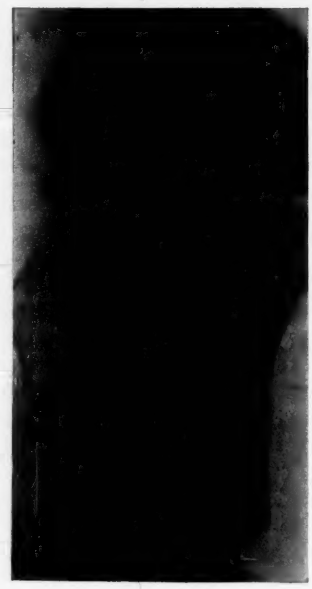


FIG. 330.
Case 11. Aug. 18, 1926.

FIG. 331.
Case 11. July 15, 1927.

Case 11.—**Leg fracture, upper fourth. Modified long Delbet plaster (*Figs.* 329–332).**

C., male, age 74, caretaker. On *Aug.* 13, 1926, was knocked down by a motor-car and had concussion; oblique fracture of upper fourth of both bones left leg with slight abduction deformity.

Aug. 19: General anæsthetic, manipulation. Long Delbet plaster.

Sept. 1: Sits up half day.

Sept. 15: Walked with help.

Sept. 22: Walks well with sticks. Can walk without sticks.

Oct. 10: Walking with one stick. Plaster removed: ½-in. shortening, firm union, active flexion of knee to right angle.

Oct. 20: Walking fairly well without stick. Much œdema.

Oct. 24: Discharged. From this date led ordinary active life, going out daily. and walking up and down stairs. Using one stick. Returned to work after few weeks.

LATE RESULT.—Seen in July, 1927, patient had no limp; ¾-in. shortening. Flexion of left knee 80 per cent. Pain in wet weather.

CONCLUSIONS.

Ankle Fractures.—

1. That X-ray examination should be made in all cases of ankle injury if severe enough to cause pain on walking; and especially that a true antero-posterior view be obtained.

2. That reduction by simple manipulation is sufficient in the great majority of recent cases. Open operation was not found to be necessary in the cases dealt with in this communication.

3. That full correction of both lateral and antero-posterior displacements of the astragalus is essential to the complete recovery of function.

4. That use of the Delbet plaster shortens considerably the period of treatment, as compared with other methods, and that it dispenses with the tedious and expensive course of physiotherapy required by them.

Leg Fractures.—

1. That actual anatomical restoration is not essential in order to regain perfect function, provided that angulation and shortening of more than one inch are corrected.

2. That full weight-transmission through the seat of fracture, made possible by using the Delbet plaster in these cases, stimulates rapid formation of strong callus and so shortens the period of treatment.

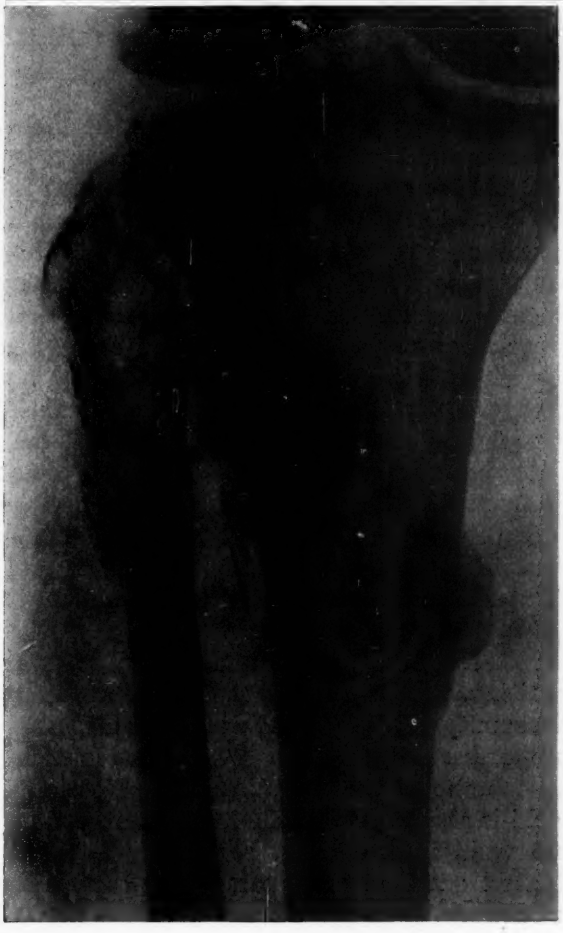


FIG. 332.—*Case* 11. July 15, 1927.

The writer wishes to thank Mr. Gwynne Williams for permission to publish his cases, for his valuable instruction, and his kind advice in the preparation of this article; also he is indebted to the Medical Superintendent of the Islington Infirmary, London, for permission to publish cases.

REFERENCE.

[1] DELBET, MARCHACK, MOSSE, and LEMARE, *Méthode de Traitement des Fractures*, Paris, 1916.

A CASE OF ACTINOMYCOTIC ULCERATION OF THE DUODENUM AND JEJUNUM.

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So far as can be ascertained from the literature, ulceration of the duodenum or jejunum from actinomycotic infection is very rare. Details could not be found of any cases resembling that which is briefly recorded in this communication. Yet actinomycosis of the buccopharyngeal region is quite common. The fungus gains access to the tissues in this situation through small abrasions during mastication, especially in the presence of defective teeth. There is a plentiful supply of the ray fungus in cereals and grasses. Fresh fruit and vegetables may be contaminated easily when packed in straw.

It is interesting to speculate on the fact that the lower jaw, the tongue, and the peribuccal tissues are readily infected, and that the pharynx and œsophagus do not always escape, and nevertheless the stomach and small intestine are practically immune. Cope, quoting Poncet, states that the thorax is frequently infected by way of the œsophagus, and that infection from the stomach and small intestine is almost unknown. It is suggested that the acid gastric juice either kills the fungus or inhibits its activity, whilst the fluid contents of the small intestine are unlikely to produce any abrasions through which the streptothrix might escape. An attack of appendicitis, on the other hand, readily gives the opportunity for which the actinomycotic organism is waiting, with the result that cæcal actinomycosis is relatively common. The immunity of the stomach and small intestine is more inexplicable when it is remembered that small breaches of surface are often present in the mucous membrane of the small intestine, especially the duodenum, and hydrochloric acid is absent or diminished in many common ailments. There appears to be no valid reason discoverable why infective material swallowed in the food should not find more often a suitable nidus for development in these high situations.

In 1924, a man of 40, a painter, was admitted to the wards of Mercer's Hospital, Dublin. He had been ill for four months suffering from vague abdominal pains, with loss of weight, loss of appetite, and gastric stasis. His temperature ranged from 99° to 101°, and cachexia was well marked. Early in the course of his illness his medical attendant in the country noticed transitory jaundice and bile in the urine. Shortly after admission to hospital he had a severe hæmatemesis. Routine bedside examination revealed nothing except tenderness and some rigidity over a wide area above the umbilicus. Hydrochloric acid was absent from the stomach contents, and raisins given at night were found in plenty on washing out the stomach the following

morning. Blood cultures were reported as negative. Only an incomplete X-ray examination could be made owing to structural alterations in the hospital: when the patient was examined in the erect position the stomach was found to be dilated and hypotonic. The report stated that there was diffuse narrowing of the pyloric segment and gross irregularity of outline in both curvatures. There was a very large six-hour residue. It was explained that the patient could not be examined in the horizontal position, but that so far as the examination went there appeared to be pyloric obstruction, almost certainly due to carcinoma. In the light of later events it became obvious that the gross irregularity was in the duodenum, the stomach having dropped in front of the ulcerated duodenum when the patient was in the erect position. The clinical diagnosis was cancer of the stomach.

The abdomen was opened in the middle line above the umbilicus. The stomach and the first portion of the duodenum were examined and were found free from ulceration or other abnormality. A general exploration was carried out, and a loop of the jejunum about one foot from the duodenojejunal flexure was found to be the site of a tumour about the size and shape of a bantam's egg. The affected coil was adherent to the omentum and to neighbouring coils of intestine. The adhesions were easily detached, and when the tumour was isolated it was found to be red and acutely inflamed on the surface, with much the appearance of an acute appendix before perforation had taken place. In two or three places perforations closed by loose adhesions passed through the inflamed areas into the lumen of the intestine. The loop of jejunum was resected and the intestine united by end-to-end anastomosis. No other lesions were discovered at operation. On the eighth day after operation the patient got a sudden pain; perforation had obviously taken place, and he died in a few hours.

At the post-mortem examination carried out by Dr. T. T. O'Farrell, the third portion of the duodenum was found to be ulcerated in much the same manner as the loop of jejunum which was resected. The immediate cause of death was leakage at the line of anastomosis.

Before the specimens were investigated by the pathologist no opinion could be formed as to the nature of the lesion in the jejunum. It was unlike tuberculosis of the small intestine, there was obviously no impaction of a foreign body, and the site of the lesion and the acute inflammatory condition almost excluded malignant disease. The accompanying coloured drawings of the specimens were made immediately after operation.

Having regard to the post-mortem findings, the remarks of Sandford and others[1] are of interest:—

"Formerly we followed the suggestion of J. Homer Wright and others as regards nomenclature, calling actinomyces only an organism of the type *Actinomyces bovis*, forming typical 'sulphur granules' with club-shaped rays, not acid-fast, and growing with difficulty in cultures, usually anaerobic. Our previous Report was made only on cases that were definitely infected with organisms of this type, the term 'nocardiosis' being applied to the disease in which the infection was caused by so-called nocardia or streptothrix, or any of the actinomyces that grow aerobically and are acid-fast. However, the Committee on Nomenclature of the American Society of Bacteriologists in its final report has recommended that all organisms of this type be now classified under the general name 'actinomyces'".

New and Figi point out the fallacy of the general belief that the most common means of infection is by direct contagion from the lower animals, the patient being generally asked if lumpy jaw exists amongst the animals in the neighbourhood. It is more likely that the organisms abound on the vegetation of the locality, rather than that the diseased animals are the primary cause of the infection in man. They refer to the picking of decayed teeth with straws or chewing bits of straw or grass as likely to produce the disease. Infection from one person to another is stated to be very unlikely.

Sandford and Magath[1] contribute also to the work on actinomycosis, and, amongst many other interesting facts, they state that there are two cases in the literature of actinomycosis of the finger, resulting from injury inflicted by an opponent's tooth in a fist fight. In both of these cases the inference is that actinomycosis was present in the oral cavity of a person who was not suffering from the clinical manifestations of the disease.

The present case illustrates the fact that occupation is not a determining factor in the etiology of actinomycosis: the patient was a painter; and probably about 50 per cent of the cases are not farmers, nor are they brought directly into contact with cattle or grain.

The facts that the glands in the present instance were not involved, and that peritonitis apart from the perforation was absent, make the picture of actinomycosis more complete. These are striking features of actinomycosis, and serve to distinguish it from other forms of infection, and especially from tubercle[2]. The peritoneum resists attack in a remarkable manner. Large masses, the result of actinomycosis, may be found within the abdomen, abscesses may require drainage, but peritonitis is seldom seen either as a primary lesion or as a post-operative complication.

In a very full clinical study of actinomycosis, Cope[2] discusses the regional distribution under the following groups: (1) Upper alimentary canal—bucco-pharyngeal; (2) Lower alimentary canal—cæcal and appendicular infection; (3) Thorax; (4) Miscellaneous—skin, genito-urinary tract, etc. There is no mention of involvement of the intestinal tract between the lower end of the œsophagus and cæcal region. It is mentioned that the liver is frequently attacked, but it is difficult to believe that this is more than a metastasis from some other focus in the alimentary tract.

Helwig[3] reports cases of actinomycosis of the ovary and tube, and brings out the interesting fact in a table of reported cases of actinomycosis that 20 out of 30 cases were secondary to an intestinal lesion. In nearly all these cases the primary lesion appears to have been in the appendix region, meso-sigmoid, sigmoid colon, rectum, or large intestine or liver.

Four cases which had their origin in the small intestine are mentioned, but no details are given.

Seventeen cases of actinomycosis are tabulated by Sandford and Magath[1] according to the anatomical distribution as seen in the Mayo Clinic. In none of these was the small intestine involved. A hundred and nineteen cases were collected from the literature and tabulated in like manner: one of this group was classified 'intestine and liver', another 'omentum and intestine'.

Mattson[4] states that there are two modes of invasion. One, which is very rare, is the generalized infection of the entire mucous membrane of the intestinal tract: only one case is on record. The other mode of invasion, which is quite common, is through the appendix.

PATHOLOGICAL REPORT.

By T. T. O'Farrell.

The material from this case consisted of: (1) A segment of jejunum removed by operation; and (2) Organs removed at autopsy.

Segment of Jejunum Removed by Operation.—This piece of intestine, which is about 10 cm. long, shows two perforations on the peritoneal aspect (*Fig.* 333), one on either side of the mesenteric attachment and about 1·5 cm. from it. The intestine about the perforations is inflamed, and some greenish slough projects from the openings. Apart from the inflammation in the immediate vicinity of the perforations there is relatively little peritonitis.

When received, the bowel had been opened along its free border. The mucous surface presents two transverse ulcers (*Fig.* 334) which are partly confluent and extend circularly around almost the entire circumference of the intestine. The ulcers are from 1 to 1·5 cm. in diameter. The edges are ragged and partly undermined, and there is a red line of intense inflammation about their margin, next to which the mucous membrane looks normal. On the whole there is comparatively little thickening of the intestinal wall. The floors of the ulcers are shaggy and covered by a dark-greenish, adherent slough. For the most part the ulcers involve the mucous and submucous coats, but at two points they extend through the muscle to the peritoneal coat where the perforations are situated. To the naked eye there is no evidence of tubercle, and the amount of thickening is much less than occurs in that condition.

Microscopical sections were made through the floor of one of the ulcers, including some of the adjacent comparatively healthy-looking mucous membrane. Sections were stained by hæmatoxylin and eosin, Gram-Weigert's, Unna-Pappenheim's, and Ziehl-Neelsen's methods.

The surface of the ulcer is covered by necrotic material, containing a moderate number of pus-cells and many bacteria. Beneath this the inflammation is of a more or less subacute or chronic type, plasma-cells are very numerous, and the general background of the structure is that of granulation tissue. There are some capillary blood-vessels, some extravasated red blood-cells, and a moderate amount of fibrin.

In the sections examined this inflammatory process extends downwards to the muscular layers, the muscle being partly infiltrated by plasma-cells and small lymphocytes. The mucous membrane at the edge, though intact, shows similar infiltration for some distance on either side of the ulcer. There is nothing suggestive of tubercle. The bacteria in the slough are cocci and bacilli, some of the latter being long and filamentous. In the floor of the ulcer there are several clumps of micro-organisms composed of branching

partly-beaded filaments arranged fan-wise in a radiating fashion, very suggestive of a streptothrix. The filaments retain Gram's stain, methylene blue, and pyronin. Fibrin, where present, though retaining the Gram's stain, is unaffected by the other two dyes. The organism is not acid-fast. Some clear areas resembling 'clubs' were found, but a successful stain was not obtained.

None of the organisms could be found in the muscular layers of the bowel. There is no evidence of malignant disease.

Post-mortem Examination. — The subject was much wasted; post-mortem rigidity and staining were well marked. A light-brown pigmentation was present on the skin of the axillæ and groins, as also on the extensor aspect of both forearms, and to a certain extent on the back of the hands.

The operation wound in the middle line was opened; immediately beneath the stitches pus was found, particularly at the upper angle. The omentum was adherent to the parietal peritoneum. On separating the parts carefully, the intestinal anastomosis was found, about 37 cm. from the duodenojejunal flexure. The anastomosis was perforated, and separated on slight handling.

FIG. 333.—Drawing made immediately after operation, showing inflamed jejunum with perforations.

There was apparently no attempt at healing. The mesenteric attachment at the base of the anastomosis was greenish and somewhat gangrenous. There was a considerable amount of seropurulent fluid in the abdominal cavity. Posterior to the anastomosis the coils of the small intestine were adherent, and the peritoneum there was covered by a greenish exudate. The intestine from the duodenojejunal flexure to the rectum was removed and opened, and appeared healthy. The mesenteric glands were somewhat enlarged.

A dissection was made of the stomach, duodenum, and pancreas. The spleen was somewhat adherent, firm, and dark in colour. The pancreas was firm, particularly towards the tail. On dissecting the second stage of the duodenum from the front of the right kidney it was found adherent, and upon trying to separate the parts a perforation was made into the gut. On the left side a perforation was found in the third stage of the duodenum, near the point where it joins the jejunum, and the retroperitoneal fat was inflamed.

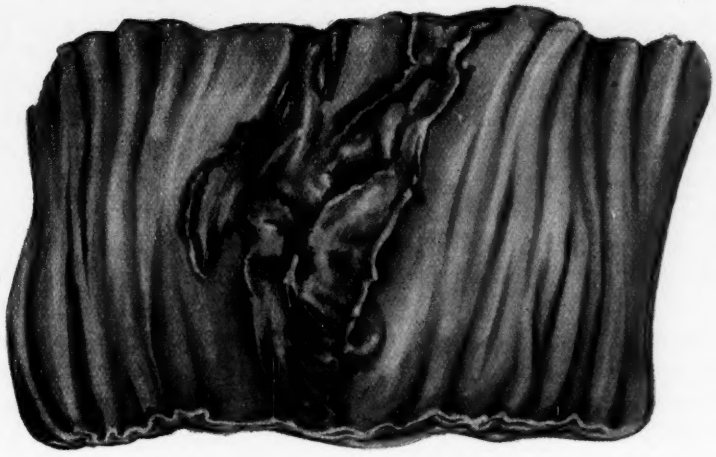

FIG. 334.—Jejunum opened, showing two transverse ulcers partially confluent. The ulcers encircled the segment of intestine.

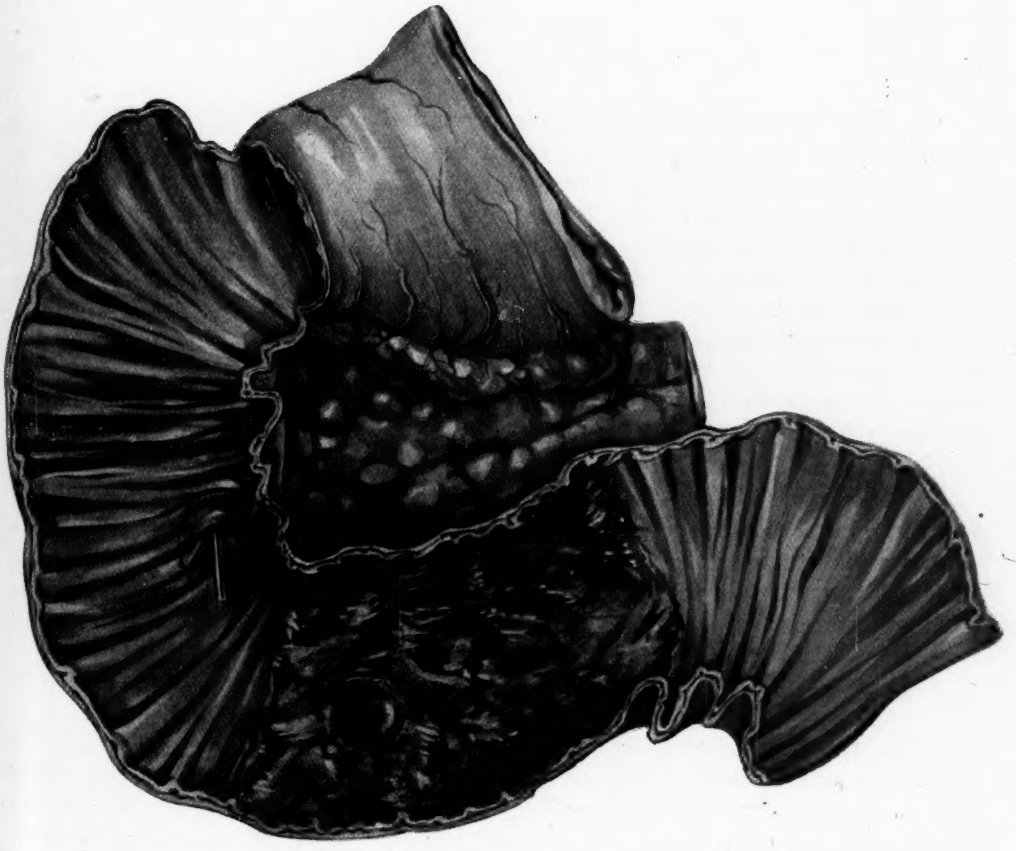

FIG. 335.—Large duodenal ulcer found post mortem, extending from the bile papilla to the duodenojejunal flexure and encircling the entire circumference.

Upon opening the stomach and duodenum a large ulcer was found (*Fig.* 335), beginning at the bile papilla, extending lengthwise as far as the duodenojejunal flexure, and circularly around the whole lining of the bowel. The ulcer had extended very deeply, and the floor was partly formed by the pancreas and the connective tissue of the posterior abdominal wall. The ulcer resembled that previously found in the piece of resected jejunum, but was more extensive and had a more shaggy greenish base. The floor was composed of a ragged mass of necrotic tissue resembling a mop.

No foreign body was found in any part of the intestinal tract. The liver showed some chronic venous congestion. The kidneys were congested, and the medullæ of the suprarenals were soft and almost liquid. The abdominal vessels were normal. An examination of the thorax failed to reveal any lesion except emphysema and some chronic pleurisy on both sides, particularly about the base of the left lung. The bronchial glands were enlarged. There was no evidence of tubercle or abscess formation. The heart was flabby, but showed no naked-eye evidence of fatty degeneration. The brain was not examined.

Pieces of tissue were selected from various organs for microscopical examination, but the only ones which presented features of interest were as follows: (1) Sections through the floor of the ulcer in the duodenum; (2) A lymphatic gland from the vicinity of the ulcer; (3) A mesenteric gland. A similar method of staining was adopted to that in the case of the jejunal ulcer.

1. *Ulcer of the Duodenum.*—This presented a similar picture to that of the jejunal ulcer, excepting that part of the floor of the ulcer was formed by the pancreas, which showed interstitial pancreatitis. Bacteria were present in the slough, and filamentous forms were numerous. Plasma-cell infiltration was remarkable. No giant cells were found. Round-cell infiltration was perhaps more marked than in the jejunal ulcer. None of the micro-organisms were found in the deepest part of the ulcer.

2. *Lymphatic Gland from the Vicinity of the Ulcer.*—This presented a curious appearance. The lymphoid tissue was separated off into islands by bands of young fibrous tissue which contained very numerous plasma-cells and some lymphoid cells. There were no pus-cells, and no micro-organisms could be found.

3. *Mesenteric Gland.*—This showed a somewhat similar appearance to the previous gland, plasma-cells being in evidence, but there was practically no fibrosis and somewhat less round-cell infiltration. No micro-organisms could be demonstrated. In none of the organs examined could any trace of tubercle or tumour formation be found.

CONCLUSION.

This patient suffered from a rare, severe, ulcerative condition of the duodenum and jejunum. The ulceration was of an almost diphtheritic type with comparatively little suppuration, the tissue reaction being mainly of the plasma-cell type with lymphoid-cell infiltration. Many micro-organisms were found in the superficial sloughs, the preponderating one being of streptothrix type. Organisms of the 'ray-fungus' type were found in the floor of the

jejunal ulcer, but only in the slough of the duodenal one. As no streptothrix was found in the lymphatic glands it is difficult to state with certainty that it was the causal agent of the ulceration, but there is sufficient evidence to consider it as being a likely factor in the process. According to Cope secondary deposits in lymphatic glands are unusual.

I am deeply indebted to Dr. T. T. O'Farrell for the infinite trouble he has taken in making the pathological examinations, and to Sir Berkeley Moynihan and Professor Stewart for supervising the painting of the illustrations from coloured pictures made at the time of operation and post-mortem examination.

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[4] MATTSON, *Ibid.*, xxxiv, 486.

CONGENITAL MALFORMATIONS OF THE MESENTERY: A CLINICAL ENTITY.

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Nearly all varieties of malformation of the mesentery and malposition of certain parts of the intestine dependent upon a disorder of reduction, rotation, or fixation of the mid-gut loop from what N. Dott[1] describes aptly as "a temporary and physiological umbilical hernia" to the abdominal cavity proper throughout the fifth to the eleventh week of fœtal life, have been dealt with by many writers. To anyone desirous of understanding the subject the work of J. E. Frazer and R. H. Robbins[2] and the lucid and masterly writings of N. Dott[1] are worthy of the most careful study. Nevertheless, nearly all the observations recorded have been made as the result of accidental findings during the course of abdominal operations for other conditions; or at operations for acute abdominal emergencies that may have arisen from such malformations, e.g., volvulus and acute intestinal obstruction; or from deliberate studies in embryology carried out in the post-mortem room. So far these gross congenital malformations do not appear to have been described in literature as definite clinical entities, characterized by definite clinical signs and symptoms, and diagnosable by clinical observations upon children who are the victims of vague abdominal disorders of a chronic nature. In the presence of acute abdominal crises which have progressed to acute intestinal obstruction they have been recognized accurately beforehand; but in milder forms the clinical features which appear to enable them to be filched from the rubbish heaps of 'dyspepsia' and 'chronic appendicitis' do not seem to have been noted so far. It is the purpose of this paper to attempt to describe these features, and its justification must be the successful diagnosis, by clinical methods beforehand, of the presence of these malformations in 4 cases out of 5 seen within the last two years, and the subsequent confirmation at operations on each case undertaken deliberately for the purpose of rectifying the lesion as far as possible.

No attempt was made at such a diagnosis in the fourth case, because all the symptoms were overshadowed by those of a very acute attack of appendicitis from which the patient had just emerged. Even in this case important physical signs were noted beforehand, but were not stressed in view of the urgent need for the removal of the appendix. The other four cases had been under continuous treatment for 'indigestion' from early childhood at the hands of many experts. It is of importance to note that this 'indigestion' made its appearance within the first few months of life, and was characterized by attacks of pain of an intensity that would be impossible to explain on the theory of a functional inability of the patients' alimentary tracts ever to digest

the many variations of diet that were offered to them. Further, the frequent recurrence over a period of years of attacks of violent abdominal pain that disappeared spontaneously on each occasion before a catastrophe happened, and left no trace behind them of detectable organic change in any of the intra-abdominal organs or their functions, comprises a sequence of events that cannot be associated with any of the well-known surgical lesions. Least of all is this characteristic of any form of appendicular trouble, although, *faute de mieux*, 'chronic appendicitis' was suggested ultimately in three of these cases. The refusal of the parents to accept the true diagnosis in one case—which was countered by a refusal to operate for the purpose of removing the appendix—led to their refusal to permit an operation for the investigation of a congenital malformation. The child was taken away for further treatment at the hands of another physician, and only fifteen months later was she brought back with no amelioration of her trouble and with the parents now willing to agree to the type of operation originally suggested (*Case* 1). In studying the details of the cases here recorded it is important to bear in mind that the segment of intestine involved is the mid-gut only, which the writers already referred to have defined as extending from the biliary papilla of the duodenum to the mid-point of the transverse colon, or alternately as all that part of the intestine which receives its blood-supply from the superior mesenteric artery.

SYMPTOMATOLOGY.

Pain.—When the pain experienced by these patients is subjected to a careful clinical scrutiny of its quality, situation, distribution, duration, and relationship to posture, to the taking of food, and to the action of the bowels, a composite mental picture of *unusualness* is at once gained. No ready-made picture leaps to the mind that can explain such a grouping by reference to any of the common and well-known surgical lesions. Children unhampered by leading questions, and with no prejudice that adults may show sometimes in the direction of trying to give an answer which they wrongly imagine the questioner wants, can describe with dispassionate accuracy where their pain is situated, and in a few simple terms can sum up its quality. This 'unusualness' can be appreciated perhaps from the following epitome :—

Case 1.—" The attacks of pain were of a violent and paroxysmal nature, experienced in the region of the right hypochondrium, and might last for only a few minutes or for a couple of hours. In the worst attacks the child would throw herself upon the floor and scream. They were liable to come on peculiarly during exertion, most frequently when she was running about playing out of doors, or towards the end of the day when she was having a final romp in the nursery before going to bed. They had no time relationship to food, and appeared to be quite unrelated to regularity or irregularity in the action of the bowels. They had been present from early childhood." (*See Figs.* 336, 337.)

Case 2.—" A gnawing pain was experienced over the area of the stomach entirely to the left of the middle line. It always began a few moments after swallowing the first few mouthfuls of a meal. It increased in intensity during the progress of the meal, and finally reached its maximum at the end of the

meal. From this point it began to die away gradually and as a rule had just disappeared before the next meal was due. It was always worse during the two big meals of the day, breakfast and dinner. Posture had no effect upon it except that the patient could endure an inevitable evil more comfortably when she was lying down, and no regulation of dietary or action of the bowels had any effect upon it." (*See Fig.* 338.)

Case 3.—"A pain like 'a bad stomach ache' was experienced on the left side of the abdomen, spreading well out to the left flank. A constant series of changes observed by the mother heralded and ushered out each attack. Their order was: Daily motions became small and pipe-like, then complete constipation for a few days, then a slow symmetrical swelling of the whole abdomen began which was followed after a varying period by the attack of pain. This might last for an hour or two or for most of the day, and was always relieved by the spontaneous passage of several enormous formed motions. The attacks of pain were not affected by posture, or by changes in diet and drugs, which had been administered for several years." (*See Fig.* 339.)

Case 4.—The malformation described was an accidental discovery at an operation for the removal of a recently inflamed appendix containing pus. (*See Fig.* 338.)

Case 5.—"The pain was very violent in character, and was experienced by the patient in the mid-epigastric region. The first attack occurred before he was 2 months old, and was accompanied by continuous vomiting, which became biliary in character. By the time he was 7 years old it was easy to recognize that these attacks were characteristic of an obstructive lesion high up in the alimentary tract."

Vomiting.—This was an entirely erratic symptom and was rare, except in *Case* 5. It only occurred in *Cases* 1 and 3 occasionally; it tended not to be continuous, but appeared rather as a single reflex act of vomiting in attacks when the pain was most intense, and the quantity and nature of the vomited material appeared to be determined entirely by what happened by chance to be in the stomach at the time.

Abdominal Examination.—In four cases a sense of *emptiness* of the right iliac fossa was a most arresting physical sign. This fossa is filled normally by large and small intestine, both of them being components of the mid-gut. Bearing in mind that these malformations affect the segment of mid-gut only, it is clear that one or other of its components must be absent from the right iliac fossa, and although it is not possible to dogmatize about which component is missing, it is quite easy to determine that the fossa is not normally filled and that one or other component must be absent; in *Case* 3 I stated beforehand that the emptiness of the right iliac fossa was due to the absence of the ascending colon, and this was proved to be quite wrong at the subsequent operation! (*See Fig.* 339.) Emptiness of this fossa has been described as a sign of intussusception; it very rarely is so, because in this disease the fossa as a rule is more than generously filled by coils of over-distended intestine which can be seen to occupy it during the course of the operation.

An asymmetrical fullness is a fairly constant sign. It was noted in *Cases* 2, 3, 4, and 5. In *Cases* 2 and 4 the whole of the colon was a left-sided

viscus; in *Case* 3 the whole of the small intestine was lying external to the left colon and was a purely abdominal viscus shut off entirely from the pelvis. In all these cases the whole of the left side only of the abdomen was swollen obviously on inspection; palpation confirmed an abnormal fullness without any evidence of tumour formation. In *Case* 5 the whole of the upper half of the abdomen was swollen; below the umbilicus it appeared abruptly flat.

X-ray Examination.—Radiography applied with the special purpose of confirming the clinical diagnosis of congenital malformation proved to be disappointing on the whole. In *Case* 1 a high cæcum was revealed (*see Fig.* 336); but the intimate relationship of the duodenum and terminal part of the ileum enclosed by a band of omentum could not, of course, be shown. No help was obtained from pictures of the other cases; but it was not realized until after the operation on *Case* 3 that the best way to obtain information as to the relative positions of the small and large intestines is to give a barium meal by mouth, and, when this has been seen on the screen to be giving a good definition of the small intestine, to administer a barium enema and thus obtain a composite picture. This method was adopted for *Case* 3 two months after operation, when a perfect picture was obtained showing that the small intestine now occupied its normal position between the three segments of the large bowel.

FIG. 336.—*Case* 1. Examination in the prone position four and three-quarter hours after barium meal. X indicates a high cæcum.

DETAILS OF CASES.

Case 1.—N. B., age 6½ years, female, was first seen on Feb. 25, 1925, with Dr. H. Waller.

HISTORY.—She had had a 'weak digestion' from infancy, and had been under continuous treatment for this by a consulting physician for the past three years. Details of the attacks of pain, which were a conspicuous feature of her weak digestion, have already been given (*see* p. 439); they had been present from her earliest childhood. The parents had been advised now that the appendix ought to be removed.

ON EXAMINATION.—The singular emptiness of the right iliac fossa was noted, but nothing else abnormal was detected. Skiagrams seemed to show that the cæcum

was under the liver (*Fig.* 336). Taking these findings in conjunction with the details of her attacks of pain, a diagnosis of congenital malformation of the mesentery was made and operation advised. The parents refused to agree to this, and as they were met with a refusal to remove the appendix, the child was placed under the care of another dietetic specialist for a further period of fifteen months. At the end of this time the child's sufferings had been entirely unaffected, and consent was given now to the performance of the operation advised originally.

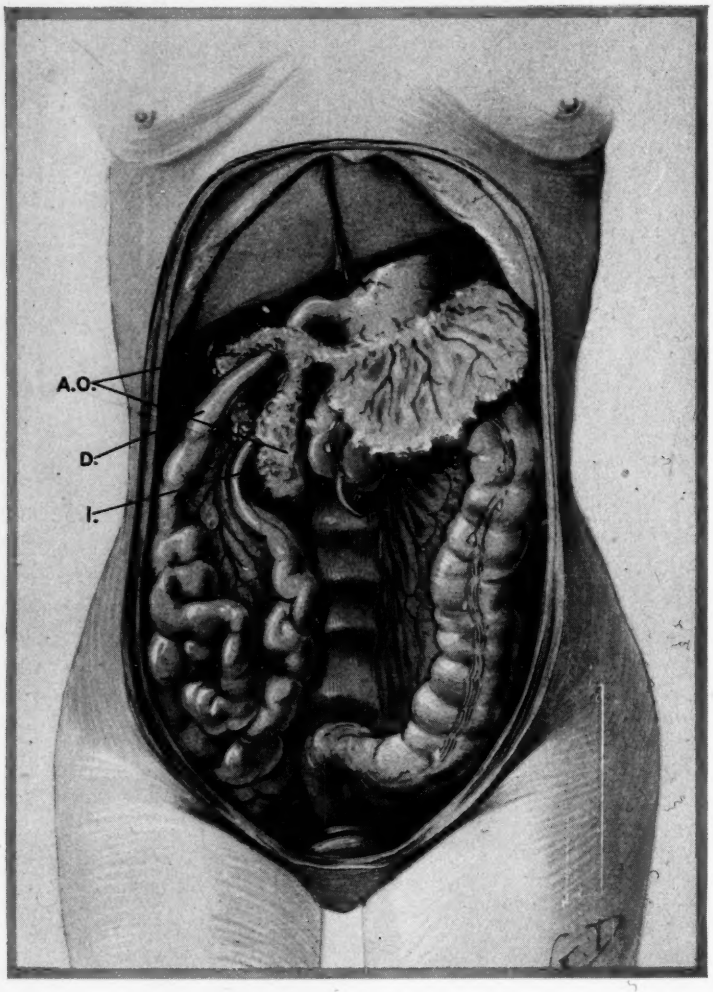

FIG. 337.—*Case* 1. AO, Abnormal band of omentum encircling: D, Duodenum; I, Terminal part of ileum; and the root of the mesentery containing the superior mesenteric vessels. The whole of the small intestine is at the right side of the abdominal cavity.

OPERATION.—Laparotomy was done on June 9, 1926. When the abdomen had been opened by reflecting the right rectus outwards, the whole of the small intestine was found to be on the right side. The duodenum was a straight tube with the terminal portion of the ileum close alongside and parallel to it. These two portions of the small intestine were bound together by a stout anomalous band of omentum which completely encircled them, and at the same time enclosed the whole of the mesentery which contained the superior mesenteric vessels (*Fig.* 337). The ileum

joined the cæcum immediately below the greater curvature of the pyloric end of the stomach; from the cæcum the large intestine passed directly to the left, so that the ascending and transverse colons appeared to be represented by a short segment of colon between it and the splenic flexure. The colon on the left side was voluminous. A small and entirely healthy-looking appendix was removed. The anomalous band of omentum was resected freely so as to liberate entirely the pedicle formed by duodenum, superior mesenteric vessels, and ileum which was constricted by it. A congenital foramen (not shown in the sketch) in the mesentery of the small intestine was closed. Nothing else abnormal was found.

RESULTS.—The child had an easy recovery, and up to the present time, October, 1927, has remained perfectly well without any recurrence of her former troubles. It would appear from a survey of all the details of the case that the constricting band of omentum was the chief factor in producing the attacks of (violent) abdominal pain, either by obstructing at intervals the lumen of one or other of the enclosed pieces of gut, or by forming a pedicle so narrow that torsion occurred in the direction of a volvulus which was prevented from becoming complete by the broad attachment of the omentum to the stomach. In favour of the latter view the liability of the attacks to be precipitated by active exercise is suggestive.

Case 2.—R. F., female, age 12 years and 4 months, seen in conjunction with Dr. R. S. Frew.

HISTORY.—All her life she had had a 'delicate inside', and at the ages of 4, 6, and 8 years respectively had had attacks of severe abdominal pain lasting for two days, and associated with the passage of blood and mucus from the bowel, so that intussusception had been suspected. Her own description of the internal pain experienced in the region of the stomach has already been given (*see* p. 439). She had been brought up on a careful diet and drugs to control the actions of the bowel daily, but at no time did she obtain any prolonged freedom from her gastric pains. She was sent up from her school at the seaside to London with a diagnosis of acute appendicitis, and I first saw her on April 22, 1925.

ON EXAMINATION.—It was appreciated that the right iliac fossa was obviously empty, and there was no tenderness anywhere. The left side of the abdomen in its lower half only was full. In view of the child's own excellent description of her pain, the presence of these signs appeared to justify the diagnosis of congenital mesenteric malformation; and the parents consented to an operation to investigate this condition. There were no signs at all of any acute illness, so that it was arranged for convenience that the operation should be done on May 6, 1925.

OPERATION.—The right rectus was turned outwards and the abdomen opened. The small intestine occupied the right side of the abdominal cavity, and the whole of the colon was on the left side; but, unlike the previous case, the cæcum was lying on the left side of the floor of the pelvis, where the ileum joined it. The ascending colon made a vertical ascent to reach the greater curvature of the stomach to the left of the middle line; from this point to the splenic flexure the transverse colon was represented by a short segment of gut only. The ascending colon was enclosed by the same primitive layer of mesentery as the small intestine; no secondary fixation had occurred anywhere, so that the whole weight of the primitive mid-gut was supported by the stomach. The condition was one of total reduction of the mid-gut with arrest of subsequent rotation and fixation. *Fig.* 338 illustrates well its further subdivision into pre- and post-arterial segments described by Dott. A small and very innocent looking appendix was removed, and the abdomen closed with the feeling that no improvement could follow.

RESULTS.—The attacks of gastric pain recurred ten days later, and continued at frequent intervals throughout the following year. Treatment was devised after operation with a view to taking the weight of the colon off the stomach as much as possible. A supporting belt was ordered, which was put on when the child was 'upside down', a diet devised to leave the smallest amount of débris, and mild aperients and paraffin to secure a rather frequent emptying of the intestine. During the present year there has been some improvement in her condition.

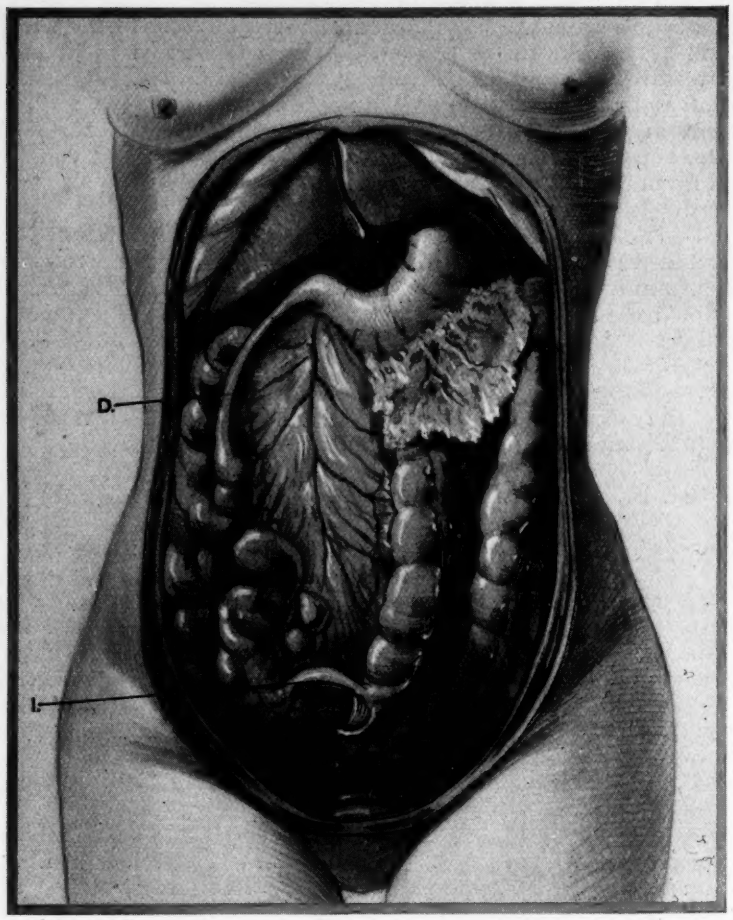

FIG. 338.—*Cases* 2 *and* 4. D, Duodenum ; I, Terminal portion of the ileum. The whole of the small intestine is at the right side, and the whole of the large intestine on the left side of the abdominal cavity. In *Case* 4 the whole of the mesentery of the ascending colon was firmly attached to the left side of the bodies of the lumbar vertebræ. In *Case* 2 no fixation of the common mesentery of the whole loop of mid-gut had occured.

Case 3.—L. B., male, age 10 years, was admitted to the Hampstead General Hospital on Jan. 28, 1927, under the care of my colleague, Dr. Scott-Pinchin, who kindly asked me to see the patient with him. Under observation in the ward an attack of left-sided abdominal pain, with distention of the abdomen and a passage alternately of 'pipe-stem' and enormous motions, had been noted.

HISTORY.—The full sequence of events which had been present from early childhood was described by the mother (*see* p. 440), who had taken him to many hospitals in London for treatment of his 'indigestion', and on two occasions had refused her permission for the removal of the appendix.

ON EXAMINATION.—He was first seen by the writer on March 21, 1927, when the left side of the abdomen was noticed to be obviously swollen ; it was full on palpation, without any evidence of tumour formation, and the right iliac fossa felt abnormally empty. A diagnosis of congenital mesenteric malformation was made, with which Dr. Scott-Pinchin agreed, and operation was decided upon after further X-ray examination. The radiograms were not helpful, and it was only after operation upon this case that the right method of procedure was worked out.

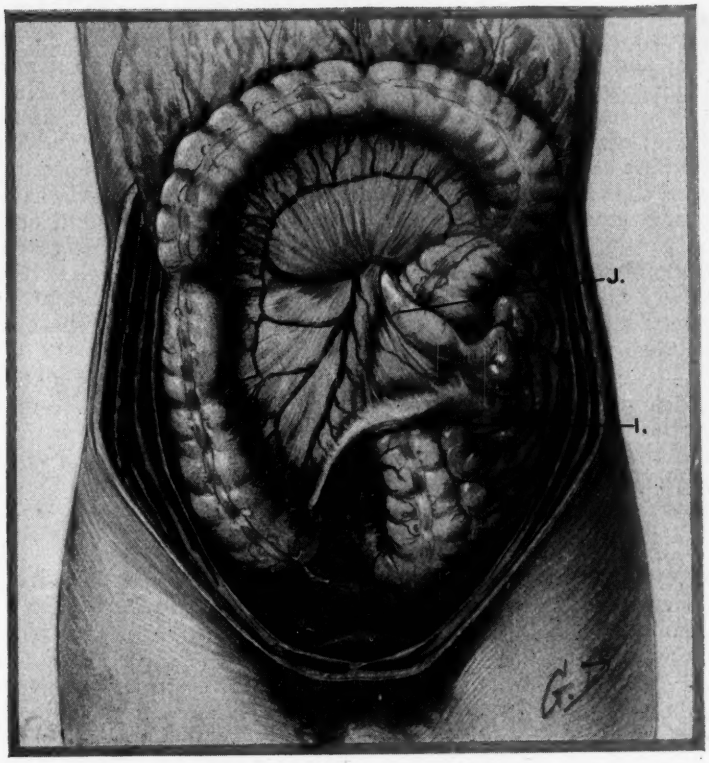

FIG. 339.—*Case* 3. J, First part of jejunum, and I, Terminal part of ileum, forming a pedicle crossing and tying down the descending colon, external to which the whole of the rest of the small intestine was lying on the left side of the abdominal cavity.

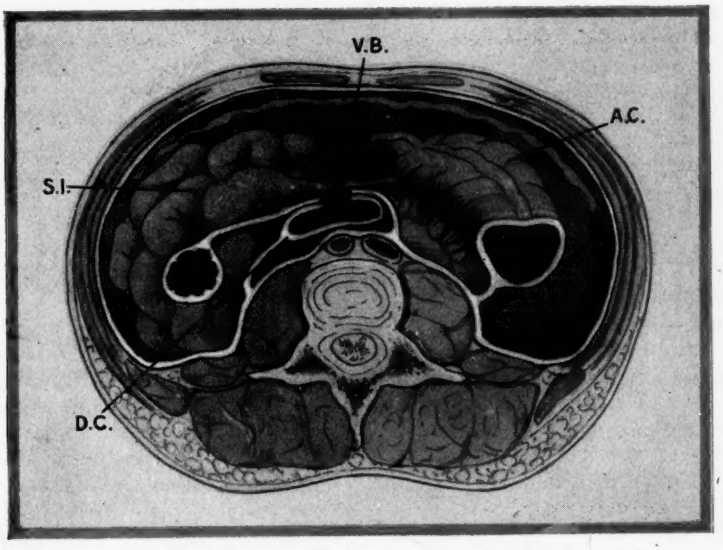

FIG. 340.—*Case* 3. Diagram of tranverse section of abdominal cavity to show the descending colon flattened by the pedicle of the small intestine which crossed it, and the vestigial band joining the mesentery of the small intestine to the anterior surface of the descending colon. This band had to be cut through before the reduction of the small intestine to its normal position could be effected. DC, Descending colon; SI, Small intestine; VB, Vestigial band; AC, Ascending colon.

Operation.—Laparotomy was performed on April 1. The *left* rectus was turned outwards and the abdomen opened. It was then found that the first part of the jejunum and the terminal part of the ileum converged to a narrow pedicle crossing and tying down the mid-point of the left colon, external to which the whole of the rest of the small intestine was lying. This latter part was confined entirely to the abdominal cavity and left iliac fossa, since all access to the true pelvis was cut off by the iliac and pelvic colon (*Fig.* 339). Where the mesentery of the small intestine crossed the left colon it was tied to it by a stout band of primitive undifferentiated embryonic tissue and the colon was flattened (*Fig.* 340), and only when this had been cut through was it possible to reduce the small intestine to its normal pelvic and abdominal situation bounded by the three segments of the colon. It settled down here quite easily without any impediment to its circulation, and without showing any tendency to return to its abnormal position. A simple healthy appendix was then removed and the abdomen closed.

Results.—The boy has remained quite well up to the present time, and has shown no tendency to a recurrence of the alternate small and large motions. Two months after the operation a skiagram of the abdomen was taken with the improved procedure, and the small intestine was clearly outlined lying in its normal position in relation to the colon. The clinical features of the case noted beforehand became easily understandable in the light of what was found at operation.

Case 4.—E. H., female, age 21 years, was seen with Dr. E. A. Seymour on Jan. 26, 1927. The symptoms of the attack of acute appendicitis from which she had just recovered need no description. They were confirmed at the subsequent operation, when an appendix full of pus with recent lymph around it was removed.

On Examination.—The emptiness of the right iliac fossa was noted, as well as a slight fullness of the abdomen on the left side. No deductions were made from these very important observations, which were overshadowed entirely by a description of the symptoms of an acute illness from which the patient had just recovered successfully.

Operation.—Laparotomy was performed on Feb. 2. The lower half of the right rectus was turned outwards and the abdomen opened. The position of the viscera was identical with their position in *Case* 2 (*see Fig.* 338). One difference—possibly of importance in view of the absence of a history of prolonged 'indigestion'—was noted in this case. The ascending colon had acquired over its whole length a secondary attachment and firm fixation to the left side of the bodies of the lumbar vertebræ, and was not contained within the fold of primitive mesentery common to it and the small intestine; in *Case* 2 the ascending colon had not formed any such attachment and was completely mobile.

Result.—The patient has been quite well since the date of operation when the appendix was removed.

Case 5.—A. V. R., male, age 7½ years, was admitted to the Hampstead General Hospital on Oct. 6, 1927, under the care of my colleague, Dr. Scott Pinchin, who kindly asked me to see the case with him.

History.—From early infancy the patient had suffered from attacks of severe abdominal pain and vomiting. The vomiting quite often occurred independently of the pain, was copious to begin with, continuous, and consisted ultimately of bile. At the age of 2 months he was admitted to a children's hospital in London and was under treatment for one month as an in-patient. He was admitted during the following seven years to four other hospitals, but the attacks had continued unaffected by any form of treatment until his admission to the Hampstead General Hospital.

On Examination.—He was a frail, sickly-looking boy when first seen on Oct. 6, and weighed 2 stone 9½ lb. The whole of the upper half of the abdomen above the transumbilical plane was distended symmetrically, and the lower half appeared flat by contrast. No mass formation was detectable, and visible peristalsis was noted high up in the *right* hypochondrium. This was clearly intestinal and not gastric

peristalsis. Radiograms of barium meals showed that retention occurred in an otherwise normal stomach for more than six hours. A second series of radiograms was taken after the administration of atropine, and these excluded pylorospasm as a possible cause of the trouble; a persistent organic obstruction of the pylorus was excluded by the presence of bile in the vomit; whilst congenital atresia of the duodenum or jejunum seemed unlikely in a patient who had reached the age of 7½ years. A congenital mesenteric malformation was therefore diagnosed which acting

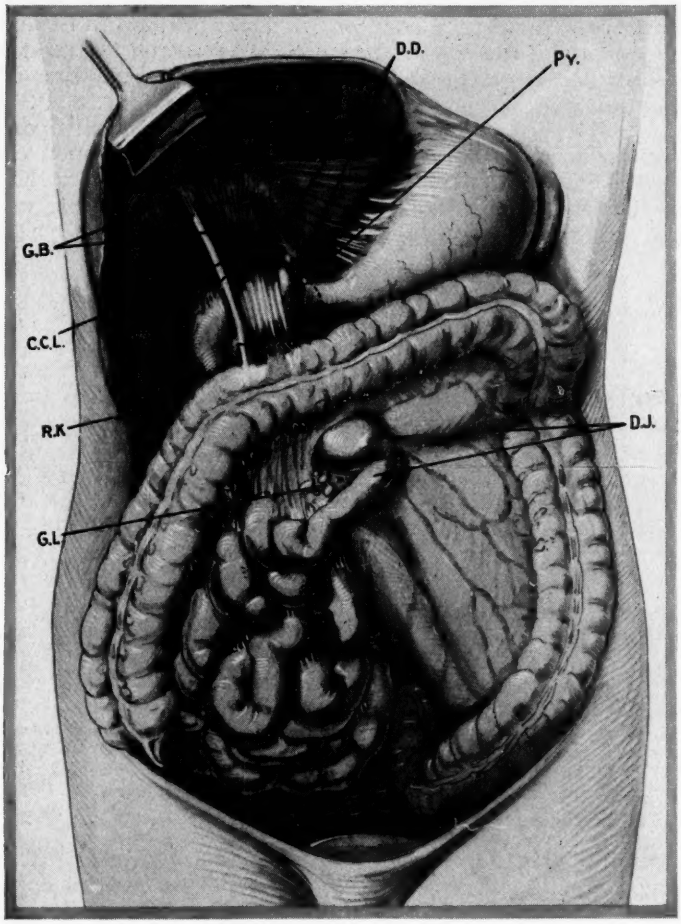

FIG. 341.—*Case* 5. GB, Gall-bladder in dotted outline beneath cysticocolic ligament; CCL, Cysticocolic ligament with thickened free edge; RK, Right kidney; DD, Dilated portion of duodenum in dotted outline beneath cysticocolic ligament; PY, Pylorus. The ascending colon and small intestine upon their common mesentery have been turned to the right to display the duodenojejunal junction (DJ). This shows an abrupt angle containing enlarged lymphatic glands (GL), and the terminal portion of duodenum dilated, in contrast with the lumen of the first part of the jejunum. The much larger masses of glands along both borders of the whole of the duodenum are not shown in the sketch.

as an extrinsic force produced intermittent obstruction high up in the alimentary tract.

OPERATION.—Laparotomy was performed on Oct. 27, and the upper half of the right rectus was turned outwards. The stomach appeared to be quite normal, and the pylorus was soft, devoid of irregularity, and admitted the tip of an index finger easily. An unusual form of cysticocolic membrane was found whose free edge was

thickened by a stout band. This band started at the transverse fissure of the liver and passed downwards across the gall-bladder, which it constricted into a figure of ∞. It then continued over the anterior surface of the second part of the duodenum to end on the hepatic flexure of the colon. The duodenum was tightly constricted at this crossing and widely ballooned above it (*Fig.* 341). The whole of the membrane was cut away up to the foramen of Winslow, with immediate relief to the constrictions of both gall-bladder and duodenum. It was then noted that the whole of the rest of the duodenum appeared to have a slightly larger lumen than the jejunum, and that the first part of the jejunum was bent at an acute angle to the terminal part of the duodenum (*Fig.* 341). This appeared to be due to abnormal mesenteric attachments of the rest of the small intestine and the right colon. These viscera were contained in a common mesentery whose sole line of attachment posteriorly was the usual one of the small intestine only (*Fig.* 342). Consequently the whole weight of the colon and small intestine combined fell upon the vascular pedicle crossing the horizontal portion of the duodenum and upon the other fixed point of the gut, i.e., the duodenojejunal flexure. As, however, the dilatation of the duodenum that might be attributed to these two factors was much less than

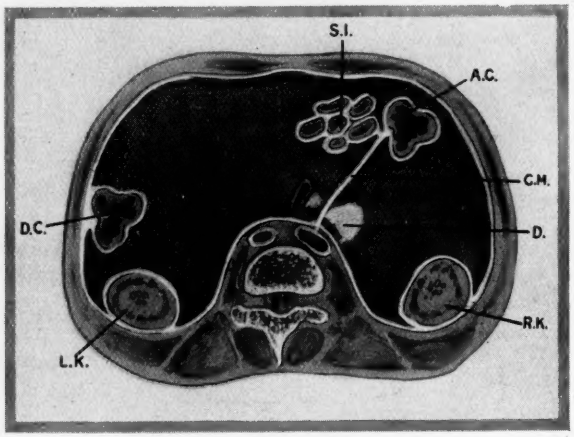

FIG. 342.—*Case* 5. Diagrammatic cross-section to show the common mesentery of the small intestine and colon and the relation of the vascular pedicle to the horizontal portion of the duodenum. SI, Small intestine; AC, Ascending colon; CM, Common mesentery; D, Duodenum; RK, Right kidney; LK, Left kidney; DC, Descending colon.

the gross dilatation above the crossing of the cysticocolic ligament, it was decided to do nothing more for the present. If the progress of the patient does not continue in a satisfactory manner, then a relief of the strain on the duodenum either by fixation of the ascending colon or by the performance of a duodenojejunostomy, as advised by Wilkie, will have to be considered.

Another feature of great interest was the presence of enlarged lymphatic glands distributed along both borders of the duodenum and forming large clusters between the layers of the gastro-hepatic omentum, over the head of the pancreas, and at the duodenojejunal junction (*Fig.* 341). There were none in the whole of the rest of the mesentery, so that this distribution appeared to suggest that a simple infection had occurred by absorption from the retained contents of the duodenum. One gland was removed for microscopical investigation, and the pathological report was to the effect that the enlargement was due to simple inflammatory changes and that there were no signs of tuberculosis. A small healthy-looking appendix was removed at the end of the operation.

RESULTS.—The general condition of the patient has improved very much since the operation, from which he had a very easy recovery. Another series of X-ray

pictures taken on Nov. 17 shows that the stomach now gets rid of a barium meal at the end of three hours—that is, just twice as quickly as before the operation. He has had no further attacks of pain, and his weight had increased from 2 stone 9 lb. to 2 stone 12 lb. on Dec. 6, 1927.

CONCLUSIONS.

1. Congenital malformations of the mesentery are a definite morbid entity of a chronic type which may be recognized before operation by careful clinical investigation.

2. The symptom-complexes to which they give rise cannot be explained by reference to any of the well-known abdominal surgical diseases; still less by any purely functional disability which may be included under the term 'indigestion'.

3. The most important physical sign is the 'emptiness' of the right iliac fossa, associated sometimes with an asymmetrical enlargement of the abdomen on the left side. These signs follow of necessity, inasmuch as the whole segment of the embryonic mid-gut is involved in a failure of rotation and fixation after reduction from the umbilical sac.

4. Radiological investigation should prove to be more helpful in confirming the clinical diagnosis when the special method of examination already described is used as a routine.

5. Operative treatment may cure the patient; alternately it may reveal a pathological condition for which a rational course of treatment may be drawn up subsequently when the precise details of the malformation have been discovered.

The sketches were made by Dr. Georges Dupuy, to whom I am much indebted, and the radiogram was taken by Dr. W. H. Coldwell.

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[1] DOTT, N. H., "Anomalies of Intestinal Rotation", *Brit. Jour. Surg.*, 1923, xi, 251.
[2] FRAZER, J. E., and ROBBINS, R. H., "On the Factors Concerned in Causing Rotation of the Intestine in Man", *Jour. Anat.*, 1915, 1.

THE BACTERIOLOGY OF CHOLECYSTITIS: A CLINICAL AND EXPERIMENTAL STUDY.*

By A. L. WILKIE, Montreal.

On no subject does such diversity of opinion exist as on the nature of gall-bladder infections. On the one hand, such observers as Hurst,[1] Knott, and Venables assert that the colon bacillus is the organism most frequently responsible and that it can be isolated from samples of bile obtained by the duodenal tube. On the other hand, Rosenow[2] has laid stress on the important rôle which the streptococcus plays in gall-bladder disease and the intramural nature of the infection. As a true knowledge of the characters and the type of infection is fundamental to a rational therapy, it is of the first importance that definite data obtained by reliable means should be available. Illingworth,[3] working in Professor Wilkie's clinic, obtained results which were roughly in accord with those of Rosenow in that he found that the streptococcus was the most frequent organism recoverable from diseased gall-bladders removed at operation.

The failure of so many observers to find the streptococcus in pathological gall-bladders must have been due to some factors in the technique employed. In this paper we hope to show what these factors are, and that an intramural streptococcic infection is by far the commonest cause of gall-bladder disease.

CLINICAL INVESTIGATIONS.

During the past few months the bacteriology of fifty consecutive cases of gall-bladder disease submitted to operation has been carefully worked out. The results obtained and their confirmation by experiment may help to remove a few of the difficulties attached to this most widely discussed subject.

The types of cases investigated may be broadly grouped under five headings: (1) Early acute cholecystitis (2 cases, rupture of gall-bladder in one case); (2) Early gall-bladder disease showing to the naked eye but slight thickening of the wall (6 cases); (3) Slight thickening of the wall associated with a single cholesterin stone (12 cases); (4) Advanced fibrosis of the gall-bladder wall without stone formation (10 cases); (5) Marked thickening of the wall with multiple stone formation (20 cases).

During the earlier part of the work Rosenow's method of culturing (1) the entire gall-bladder wall and (2) the submucosa† was employed. Along

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* From the clinic of Professor D. P. D. Wilkie, Royal Infirmary, Edinburgh, and the Surgical Research Department of the University of Edinburgh.

† The term 'submucosa' as used throughout this paper signifies the subepithelial layer. As pointed out by Halpert,[4] there is no true submucosa in the gall-bladder comparable to that found in the stomach or intestine.

these lines it was found that a streptococcus (as described by Rosenow) could be isolated in a considerable number of instances from the submucosa, but that it was most difficult to obtain the same organism when the whole gall-bladder wall was cultured. If the bile were infected, then of course that particular infecting organism was obtained from the cultures of the entire wall. In the vast majority of instances, however, the bile was sterile, and, even though a streptococcus was isolated from the submucosa, cultures of the entire gall-bladder wall failed to reveal a growth.

It was therefore clear that the only difference between the cultures of (1) the entire gall-bladder wall, and (2) the submucosa and outer coats, was the presence in the former of mucous membrane coated with bile, which of course was not present in the latter. Furthermore, in making cultures from the submucosa the small portion of this layer taken might or might not contain at the time living micro-organisms.

Bile the Inhibitory Factor.—In order to explain the peculiar fact that entire wall cultures proved sterile whilst the submucosa showed streptococci, the organisms were treated with sterile bile. The sterile bile used in each case was obtained from the same gall-bladder from which the organisms were cultured. It was found that a few drops of bile inhibited the growth of the streptococci, and the organisms were ultimately killed, subcultures showing no growth. In other words, the streptococci isolated from the submucosa were not 'bile-resistant'. It appeared to be somewhat of a quantitative action, as more bile was necessary in heavier than in lighter growths to produce uniform results.

A great obstacle to the isolation of gall-bladder infective organisms, however, still remained, for the culturing of the submucous coat was very unreliable and not suited for bacteriological purposes when dealing with a number of cases at one time. The difficulty was obviated by Professor D. P. D. Wilkie, who suggested that in all cases of cholecystitis the cystic lymph gland should be carefully studied both histologically and bacteriologically. This gland, situated near the junction of the cystic duct and the gall-bladder, has now been shown to drain the entire submucous and outer coats of the gall-bladder. His proposal was carried out and has led to some very interesting and instructive results.

The importance of the study of the cystic gland in gall-bladder disease cannot be over-stressed, as it provides not only an easy but a certain means

Results of Gall-bladder and Cystic-gland Cultures in 50 Cases of Cholecystitis.

Cultures from:	Streptococcus	B. coli	B. welchii	No Growth
	Cases	Cases	Cases	Cases
Bile	2	3	1	44
Gall-bladder wall (all coats) ..	2	3	1	44
Submucosa ..	21	—	1	28
Cystic gland ..	43	1	1	5

for the isolation of organisms which lodge and flourish in the gall-bladder wall. Using this technique, the results obtained were most striking, not only on account of the regularity with which organisms were found, but also in the uniformity of their type.

From the table the importance of cystic-gland cultures may readily be seen. In 43 cases the gland gave a pure culture of streptococci, in 1 case *B. coli*, in 1 case *B. welchii*, and in only 5 cases proved sterile. In the 43 cases all grades of cholecystitis were included. *B. coli* was isolated in one instance where a fault of technique could not be excluded, as the bile contained *B. coli* and there was a slight escape of gall-bladder contents during transportation from the operating theatre to the laboratory. *B. welchii* appeared in a case where a partial cholecystectomy had been done some years previously for an acute gangrenous cholecystitis. Of the 5 cases in which the gland proved sterile, in 2 the gall-bladder changes were very slight and the gland showed no enlargement. (As will be shown, cystic glandular enlargement is one of the first gross signs of cholecystic disease.) The 3 remaining cases in which the gland is tabulated as sterile presented gall-bladders so greatly thickened with long-standing disease that the cystic gland itself could not be isolated from the mass of fibrous tissue at the neck of the gall-bladder, and consequently a portion of this tissue was used for culture.

In addition to the cystic-gland cultures, the bacteriology of the submucosa, the entire gall-bladder wall, and bile was carefully studied in each case. As may be seen from the table, of the 43 cases which showed streptococci in the cystic gland, positive cultures of this organism were obtained in only 21 instances from the submucosa. This fact clearly demonstrates that with ordinary simple technique the organism may be recovered much more easily from the cystic gland than from the submucosa. When, however, streptococci were isolated from the submucosa, they proved to be of a type similar in every way to those recovered from the cystic gland.

The results obtained from culturing the gall-bladder wall (all coats) resemble those from the bile in every detail. The two cases which showed streptococci in the bile also contained streptococci in the cystic gland, but subsequent investigation proved that the two types were not similar. The strain isolated from the bile presented a rougher growth on agar, and appeared slightly larger than the organism from the cystic gland or submucosa, and when injected into animals no pathological changes resulted. It should be noted in passing that these bile-resistant streptococci were found in the two acute cases of the series, one of which showed a rupture of the gall-bladder with resulting peritonitis. These organisms were not demonstrated in the cystic gland or in the submucosa.

B. coli appeared in the bile in only 3 cases, in each instance associated with multiple stone formation and great fibrosis of the wall, indicating long-standing disease. In no instance was *B. coli* recovered from the submucous coat, and, in the one case in which it was isolated from the cystic gland, contamination by bile could not be excluded. The occurrence of *B. welchii* has already been explained.

In 44 cases the bile was sterile, both in the presence and absence of stones, but in a few of these instances *B. coli* was found in the centre of calculi.

In spite of the sterility of the bile, streptococci were present almost always in the cystic gland.

Technique used for Cultures.—

Cystic Gland.—In order to obtain the best results in culturing the cystic gland, it was found necessary to follow a few simple but important rules. When removing the gall-bladder the cystic gland in each case was included. This presented no difficulty, for in the majority of instances it was enlarged and could be palpated or seen, even before the cystic duct was severed. A ligature was tied tightly around the distal end of the cut cystic duct to prevent any escape of gall-bladder contents. Keeping everything in a sterile condition, the cystic gland was carefully dissected, removed from the surrounding tissue, minced up finely with scissors, and placed in a tube of warm glucose broth. By dividing the gland into sections, as many tubes were used as desired. The broth containing the gland was then incubated for from four to six hours, after which time the tissue was removed from the medium. The latter was then re-incubated for from twenty-four to forty-eight hours. By trying various methods this was found to be the most efficient. The growth was often slow, being almost imperceptible in twenty-four hours apart from a very faint opalescence. Glucose broth, being simple to prepare and free from any cloudiness, was found to be more convenient than Rosenow's brain-tissue medium and quite as efficient. The latter, unless fresh and very carefully prepared, tends to be slightly opalescent at the bottom of the tube, and thus an early growth is difficult to recognize.

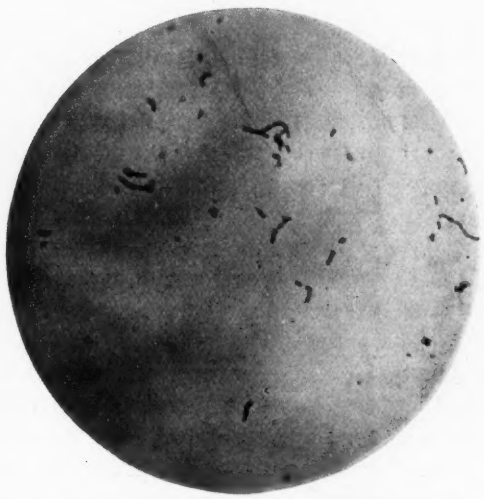

FIG. 343.—Appearance of streptococci isolated from the cystic gland growing in glucose broth.

If the gland tissue was not removed in a few hours, the final growth appeared to be less abundant and the organisms tended to die, probably owing to the action of toxic products from autolytic changes in the lymphoid tissue. If the growth, even though slight, was subcultured in glucose broth, at the end of twenty-four hours an abundant culture of streptococci resulted. The growth tended to settle to the bottom, and with gentle movement of the tube was seen to rise in a cloudy white adherent mass. This or the original growth was used for further investigation, for a single subculture did not appear to alter the reactions or virulence of the organism. Further subcultures seemed, on the other hand, to be unsatisfactory unless they were grown on agar slants.

On stained smears the streptococci appeared mostly in short chains (*Fig.* 343), provided that the cultures were made by the method laid down. Occasionally they existed in diploid form, were medium-sized, and produced smooth, non-hæmolytic, whitish colonies on blood-agar. The streptococci

from the bile, on the other hand, tended to be slightly larger and produced colonies of a distinctly rougher type. Although sugar reactions in streptococci appear to be of doubtful value, it may be stated that in fresh cultures the cystic-gland strains ferment lactose, mannite, and salicin with great regularity, whereas the type isolated from bile ferments saccharose also.

Submucosa, Gall-bladder Wall, and Bile.—A similar technique was used in culturing the submucosa and outer coats, the gall-bladder wall in its entirety, and the bile. In dealing with the submucosa care was taken to strip the outer coats in order not to penetrate the mucous membrane; by scraping the stripped surfaces and mincing the outer coats reliable cultures were obtained. In dealing with the entire gall-bladder wall the mucous membrane, previously washed, was employed along with the remaining coats. Bile was cultured in the ordinary way. These various cultures were carried out in every case, and were handled by the same methods as those used for the cystic gland.

Importance of the Study of the Cystic Gland.

The growths obtained from the cystic gland have special interest, apart from the mere isolation of an organism. They point to the marked degree of lymphatic absorption from the wall of the gall-bladder when that organ is diseased. The method furnishes an accurate means of obtaining in pure culture organisms derived from the gall-bladder wall. It is noteworthy that in this series of observations, whenever organisms were found within the wall, similar bacteria were isolated from the gland. This method obviates the difficulty of separating intramural organisms from any which may be growing in the lumen of the gall-bladder. The latter represent, it would appear, a secondary infection, remain solely in the lumen of the gall-bladder, are not found in the lymphatic drainage of the part, and are therefore in all probability of minor importance.

In reviewing this series, and many other cases of cholecystitis which have come to operation in Professor Wilkie's clinic, gross changes in the cystic gland have been noted. In normal gall-bladders this gland was rarely palpable and seldom seen. In early gall-bladder disease showing a mild degree of thickening, with or without the presence of a stone, the gland invariably showed definite enlargement. It was easily palpable, enlarged perhaps to the size of a small bean, and could be readily exposed. At this stage streptococci were always found in culture. In cases of more advanced cholecystitis the gland was more difficult to find, and in some cases was completely hidden by the effects of advanced disease.

The microscopic appearances in early cases were those of a lymphoid hyperplasia; in later cases fibroid changes predominated.

EXPERIMENTAL PRODUCTION OF CHOLECYSTITIS BY INJECTION OF STREPTOCOCCI ISOLATED FROM THE CYSTIC GLAND.

In attempting to prove the bacteriological etiology of any disease it is necessary to reproduce the identical gross and microscopic pathological changes by the injection of the particular organism into previously normal animals.

This procedure has been adopted in regard to organisms isolated from the cystic gland, and the results obtained have been quite striking in nature. Fresh agar cultures of streptococci isolated from the cystic gland (draining diseased gall-bladders) were suspended in saline (about 250 million per c.c.). These suspensions were used for injection purposes. Rabbits were the animals chosen to work with, as they were found to be the most convenient, especially when repeated intravenous injections had to be given. Control experiments were carried out in all cases.

The experiments may be broadly grouped under five headings : (1) *Injection of streptococci directly into the lumen of the gall-bladder ;* (2) *Injection of streptococci directly into the gall-bladder wall ;* (3) *Injection of streptococci directly into the gall-bladder wall with the cystic duct occluded ;* (4) *Intravenous injection of streptococci ;* (5) *Intravenous injection of streptococci with the cystic duct occluded.*

1. **Injection of Streptococci Directly into the Lumen of the Gall-bladder.** —When streptococci isolated from the cystic gland were introduced into the lumen of the rabbit's gall-bladder, no changes whatsoever resulted. Within a very short time the bile was again found to be sterile. The gall-bladder wall remained in its normal state, and no lesions were demonstrated in any other organ. Similar negative results were obtained when streptococci of the type isolated from bile were injected.

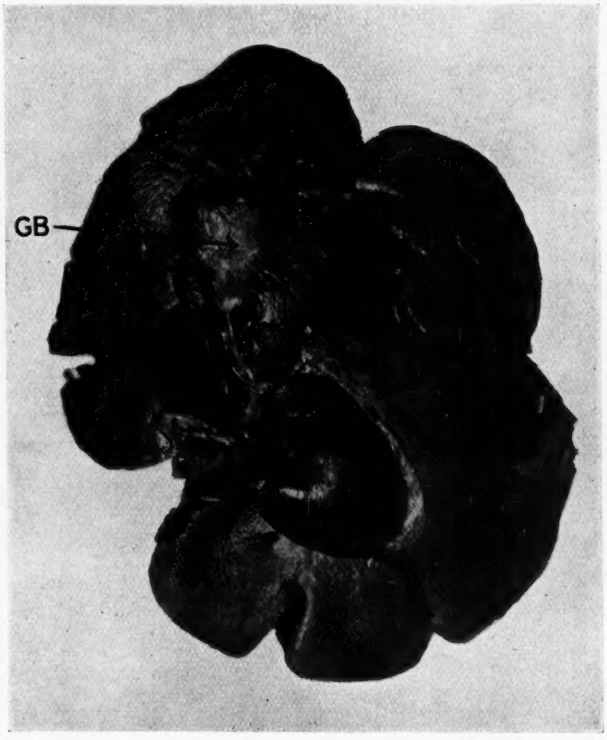

Fig. 344.—Photograph of rabbit's gall-bladder (GB) three months after direct inoculation with streptococci. Marked thickening of gall-bladder wall and cystic duct. Inflammatory processes invading surrounding liver substance.

2. **Injection of Streptococci Directly into the Gall-bladder Wall.** — In order to produce intramural pathological changes when streptococci were injected directly into the gall-bladder wall, it was found necessary to exercise great care that the mucous membrane was not perforated. The fine folds of peritoneum covering the gall-bladder at its junction with the cystic duct formed the ideal site for injection. One to two minims of suspended streptococci were quite sufficient to produce marked changes. Animals so treated, when explored at the end of one week, presented very interesting and uniform features. At the point of injection, and for a short distance towards

the fundus of the gall-bladder, the wall appeared greyish-white and thickened. The cystic duct remained quite normal. These changes at the neck of the gall-bladder contrasted markedly with the fundus, which still appeared healthy. As a rule the gall-bladder was slightly more distended than normal, but the bile showed no visible change and was sterile on culture. At the end of a month the entire gall-bladder wall showed marked evidences of thickening, and was whitish and opaque in appearance. Radiating from the gall-bladder, small opaque thickenings were seen on the liver substance, and in one animal where repeated observations were made over a period of weeks these opaque inflammatory processes were seen to be spreading centrifugally from the gall-bladder.

When these animals were killed after a period of three months, the gall-bladder changes were most striking. The organ appeared as a tough, whitish, leathery pouch, uniformly and enormously thickened (probably eight to ten times its original thickness) by a gross production of inflammatory connective tissue (*Fig.* 344). The mucous membrane was yellowish-white in appearance, The contents showed changes that seemed to vary with the amount of constriction of the gall-bladder outlet and the degree of change within the wall. In early cases, where changes were not marked, the gall-bladder was filled with rather thin bile mixed with a certain quantity of mucus. In more advanced cases the contents were mucopurulent, and as a general rule a few small pinhead-sized calculi were present. These stones were moderately hard, greyish-yellow in colour, and on chemical examination (Dr. I. S. Ravdin) were found to be made up of *cholesterin, no calcium* being present. No growth of any organism was obtained from the contents of the gall-bladders in this group of experiments, but the submucosa and outer coats, both in stained sections and on culture media, proved to be infected with streptococci of the same variety as those used in the original inoculation (*Fig.* 345). Histological examination showed an enormous increase in fibrous tissue in the submucosa and outer coats, with scattered areas of small round-celled infiltration (*Figs.* 346–349). An increase in the amount of fat was demonstrated in the submucosa by special fat stains. The mucosa showed an increase of lipoid material, and the cells appeared œdematous and swollen.

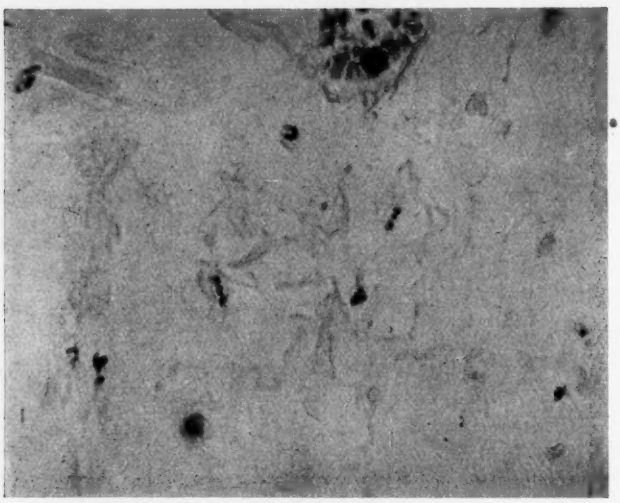

FIG. 345.—Streptococci in wall of rabbit's gall-bladder three months after direct inoculation.

Sections of the liver in the vicinity of the gall-bladder showed an

interlobular increase of fibrous tissue with round-celled infiltration, suggesting a chronic pericholangitis (*Fig.* 350). Areas of fatty infiltration of the liver substance were also frequently observed.

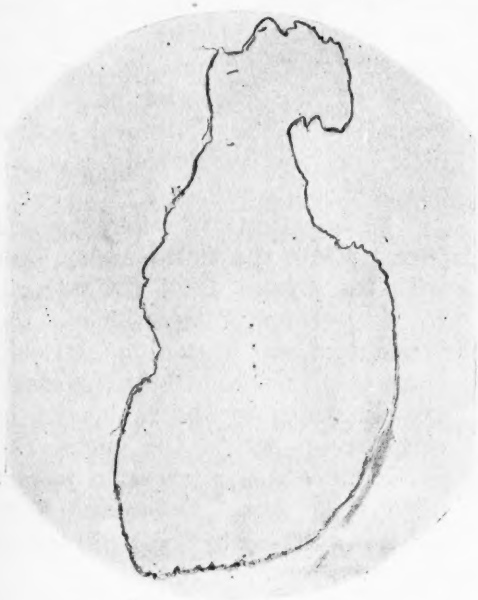

FIG. 346.—Very low-power microphotograph of a complete cross section of a normal rabbit's gall-bladder. The loss of mucous membrane in certain areas is an artefact. (Compare with *Fig.* 347.)

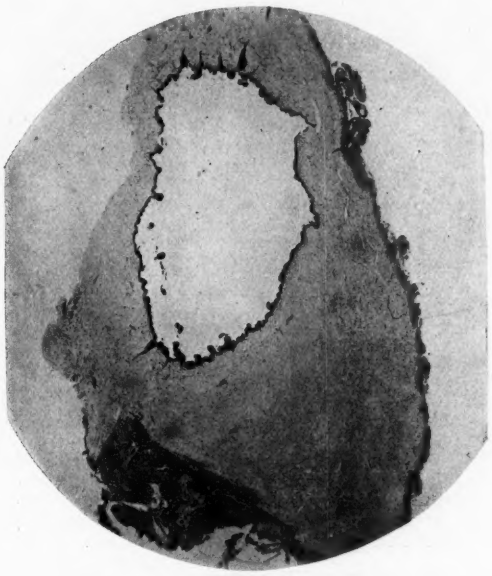

FIG. 347.—Very low-power microphotograph of a complete cross-section of a rabbit's gall-bladder three months after direct streptococcal injection. Note the enormous thickening due to fibrous-tissue production. (Compare with *Fig.* 346.)

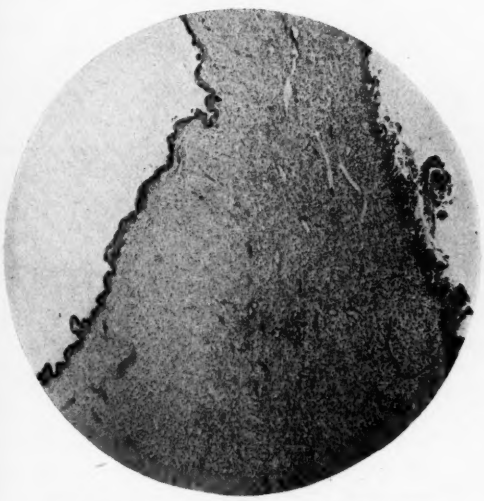

FIG. 348.—Ordinary low-power microphotograph of a portion of *Fig.* 347. Note scattered areas of inflammatory cells.

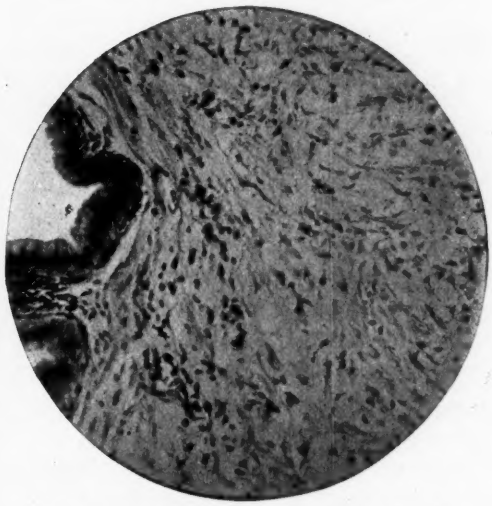

FIG. 349.—High-power microphotograph of a portion of *Fig.* 347. Note that thickening is due to inflammatory fibrous-tissue production associated with inflammatory cell infiltration. A few strands of muscle fibres are shown. The mucosa is intact.

The remarkable fact in these experiments was the slow and progressive spread of the inflammatory process from a localized area at the point of inoculation throughout the entire wall of the gall-bladder. In one or two instances, where by accident some of the bacterial suspension escaped into the peritoneal cavity, little or no peritoneal reaction occurred.

FIG. 350.—Section of liver near site of infected gall-bladder of rabbit, showing interlobular fibrous-tissue production and inflammatory cell infiltration; chronic (productive) pericholangitis. The ducts are intact.

3. **Injection of Streptococci Directly into the Gall-bladder Wall with the Cystic Duct Occluded.**—In this group of experiments the cystic duct was ligated, special care being taken not to include the cystic vessels, which in the rabbit lie in close proximity to the duct. The gall-bladder was allowed to remain filled with bile. Organisms were then injected into the gall-bladder wall as before.

The early changes were much the same as those in the preceding group of experiments, but the late results were quite different. The intramural changes were marked by generalized thickening, the result of fibrous-tissue production, but the mucous membrane was paler, and the gall-bladder contained thick mucopurulent material with a great amount of granular débris appearing as fine sand and adhering to the mucous coat. The gall-bladder contents contained a great deal of this material, which had coalesced to form multiple soft calculi, and which on chemical examination contained a large amount of calcium as well as cholesterin. In several cases streptococci were isolated from the mucopurulent contents, but these organisms proved to be of a 'rougher' type than those employed for the original intravenous injections. The streptococci isolated from the outer coats of the gall-bladder corresponded in every way to those of the culture used for inoculation.

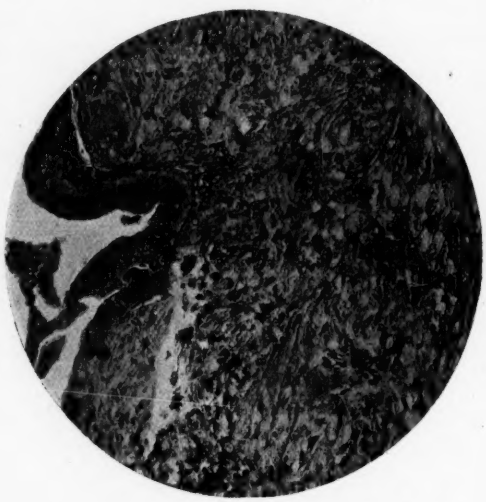

FIG. 351.—High-power microphotograph three months after direct injection of streptococci into the wall of a rabbit's gall-bladder, the cystic duct having been previously ligated. Note marked replacement of various coats by inflammatory fibrous tissue. Calcium and cholesterin stones were recovered from the lumen.

Histologically the gall-bladder wall showed marked replacement of the submucosa and outer coats by inflammatory fibrous tissue, associated with scattered areas of small round-celled infiltration (*Fig.* 351). The mucous membrane showed no noteworthy changes.

It should be noted that the only difference in technique between this and the preceding group of experiments was the occlusion of the cystic duct, which was carried out in this group and not in the former. Control animals with the duct ligated and sterile saline injected showed only an ordinary mucocele of the gall-bladder. The wall and contents remained sterile, and no evidence of intramural inflammatory changes could be discovered. Any differences, therefore, in the results in these two groups of experiments must have been due solely to the effects of the occluded cystic duct. The main difference was found in the gall-bladder contents. In the preceding group the contents were sterile, and the calculi which formed were made up of cholesterin alone. In this group streptococci were often isolated from the mucopurulent material, and the stones which formed contained calcium as well as cholesterin. The intramural inflammatory changes were quite similar.

4. **Intravenous Injection of Streptococci.**—In dealing with intravenous injections of streptococci it was found that the most striking results were obtained when repeated doses were given at intervals. More than one injection, however (at approximately weekly intervals), produced marked changes in the gall-bladder wall. The average intravenous dose of streptococci given was 1·5 c.c. of a 250 million per c.c. suspension in saline. If, on injection into the ear vein of the rabbit, some of the suspension by accident entered the surrounding tissue, no local reaction resulted. As already stated, it was found very difficult to produce gall-bladder lesions with a single injection, but after two or more inoculations obvious changes were observed. These at first were characterized by an irregular whitish opacity of the gall-bladder, more marked in some areas than in others, and as a general rule a distention of the organ was seen. If the animals after a few injections were allowed to live two or three months, a typical chronic cholecystitis was found to have developed. This was characterized by a whitish leathery thickening of the entire wall, from the submucosa of which streptococci were recovered. The contents were often purulent, but proved sterile on culture. It was noticed, however, that the pathological changes produced by intravenous injection were much slower in developing than when the streptococci were introduced directly into the gall-bladder wall.

FIG. 352.—Microphotograph of streptococci in the wall of a rabbit's gall-bladder three months after intravenous injection of these organisms.

The histological mural changes were identical with those already described, and by the Gram method streptococci were demonstrated in the outer coats (*Figs.* 352–356). Calculus formation took place in several instances. The calculi contained only cholesterin with no trace of calcium.

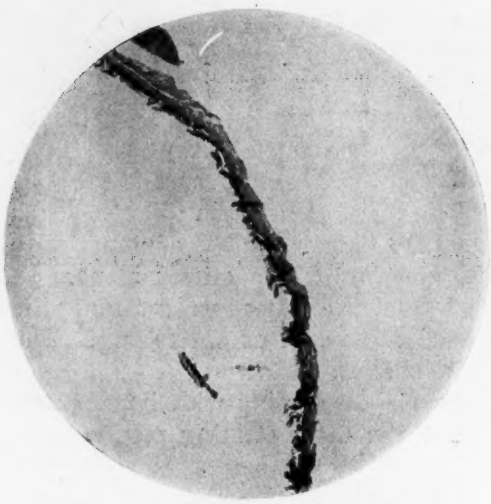

FIG. 353.—Low-power photograph of wall of normal rabbit's gall-bladder. (Compare with *Fig.* 354.)

FIG. 354.—Low-power photograph of rabbit's gall-bladder three months after intravenous injections of streptococci. Note marked thickening and inflammatory cell infiltration. The mucosa appears intact. Compare with normal picture, *Fig.* 353.)

FIG, 355.—High-power microphotograph of a portion of *Fig.* 354. Note inflammatory cell infiltration, especially marked in the lamina propria mucosæ. The outer coats have been replaced by fibrous tissue. The lumen contained one cholesterin stone.

The following experiment, which was typical of this group, supports Rosenow's contention that certain strains of organisms isolated from certain viscera have a selective affinity for those special organs.

A rabbit received an intravenous injection (into the ear) of 1·5 c.c. of a suspension of streptococci isolated from a cystic gland removed during cholecystectomy. The animal was explored each week in order carefully to observe the gall-bladder changes. The first inoculation produced no results. (This was found to be true of all animals, even after long periods of waiting, when only one inoculation was employed.) A second injection was given at the end of one week, and a few days later, when a laparotomy was done, early cholecystic changes were noted in the form of opaque thickenings at different locations in the gall-bladder wall. A few days after the third inoculation the changes had become more pronounced, the thickened areas appearing larger and tending to coalesce. The gall-bladder was slightly distended, and inflammatory processes were seen radiating from it and invading the neighbouring liver substance. The animal received six weekly doses, and on each exploration the lesions were seen to be more marked. Thickening of the wall progressed, and the inflammatory streaks proceeded farther along the liver surface.

At the end of ten weeks the animal was killed. The gall-bladder showed enormous thickening, contained one cholesterin stone, and was filled with purulent material, which on culture proved sterile. Streptococci were isolated from the outer coats. Histological changes were identical with those already described.

By such experiments the progress of the disease was carefully observed from week to week, and the factor of trauma was eliminated by similar operations on uninoculated control animals.

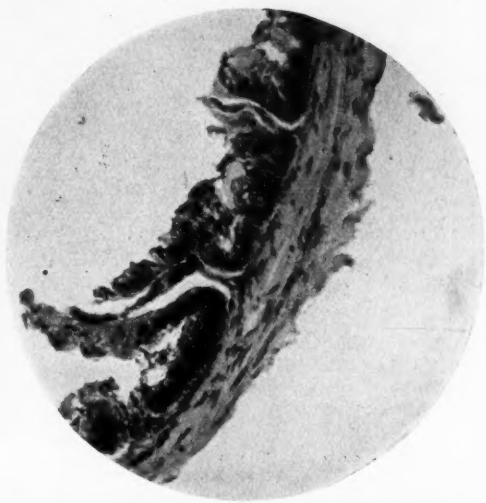

Fig. 356.—High-power microphotograph of normal rabbit's gall-bladder. Note normal thickness of the wall under this power.

Positive results were obtained in every case after repeated intravenous injections. A point not without significance was the fact that after one intravenous injection little change could be detected in the gall-bladder, whereas after a second inoculation obvious changes were invariably found.

5. **Intravenous Injection of Streptococci with the Cystic Duct Occluded** (*Figs.* 357–360.)—A similar technique was used in this group of experiments, but, in addition, in all animals the cystic duct was ligated previous to the intravenous injection. The cystic vessels were not included in the ligature.

The early changes were identical with those described under the preceding groups, except that the gall-bladder contained a great amount of mucopurulent material. When the disease reached an advanced stage, generalized thickening by fibrous-tissue production was observed throughout the gall-bladder wall. The contents proved to be mucopurulent, containing small calculi and sand-like granules as in the experiments of *Group* 3. The calculi and granules were rich in calcium but contained *relatively* little cholesterin. In one animal a streptococcus was isolated from the mucopurulent contents, in another *B. coli*; all others gave no growth. The gall-bladder submucosa and outer

coats, both in stained sections and on culture, showed streptococci, corresponding in character to the original organisms injected. (The streptococcus previously mentioned isolated from the gall-bladder contents appeared, as in other cases, to be of a 'rougher' type.)

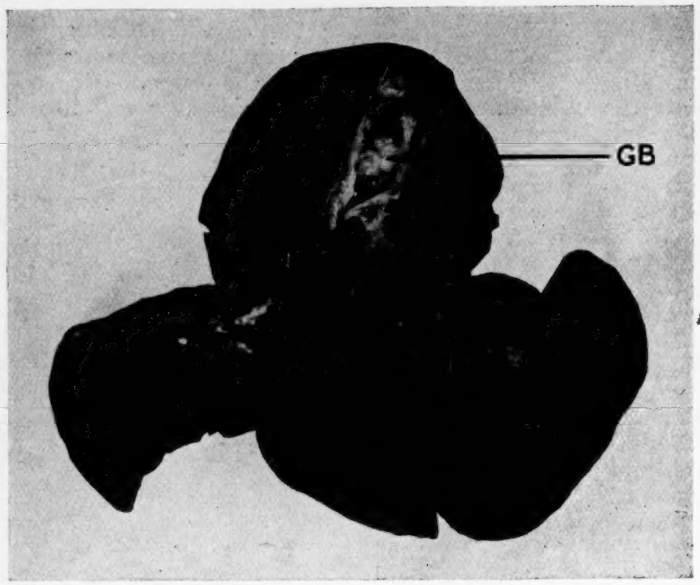

FIG. 357.—Photograph of rabbit's liver and gall-bladder (GB) three months after repeated intravenous streptococcal injections with the cystic duct tied. A portion of the gall-bladder wall has been removed to show formation of calculi made up of cholesterin and calcium. Note great thickening of the walls.

FIG. 358.—Skiagram of rabbit's gall-bladder three months after intravenous streptococcal inoculation with the cystic duct ligated. Note presence of one large stone composed of calcium and cholesterin.

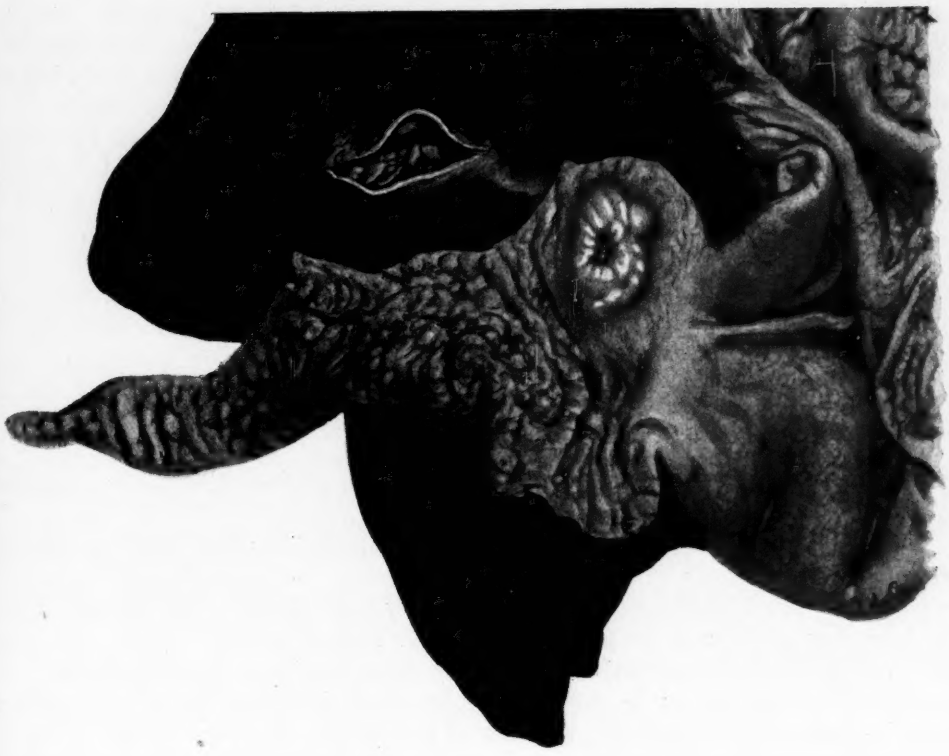

FIG. 359.—Actual drawing of rabbit's gall-bladder showing marked thickening of wall and formation of multiple stones composed of calcium and cholesterin. This lesion was produced by direct injection of streptococci. The duodenum shows a chronic ulcer.

FIG. 360.—Cholecystitis experimentally produced in gall-bladder of rabbit by injection of streptococci isolated from the human cystic gland. A portion of the fundus has been removed to show the interior of the gall-bladder and the enormous thickening of the wall.

The chief deduction to be drawn from this group of experiments was the fact that the streptococcus reached the gall-bladder by the blood-stream and caused similar intramural changes whether the cystic duct was occluded or patent. This fact was confirmed by modifications of these experiments.

In order to obviate the possibility of a lymphatic spread from the liver, as has been suggested by Graham,[5] the gall-bladder was dissected from its liver bed, the only attachment remaining being the cystic vessels and the ligated cystic duct. A portion of omentum was then interposed between the gall-bladder and the liver. Following intravenous injections of streptococci, cholecystitis developed as in previous experiments. In this experiment the cystic artery was the only possible means of conveying the streptococcus to the gall-bladder wall.

CONCLUSIONS.

1. In the vast majority of cases of chronic cholecystitis in the human subject the bile is sterile on culture.

2. Cultures of the whole thickness of the gall-bladder wall most frequently give no growth.

3. Cultures from the submucous and outer coats leaving the mucosa intact have given a growth of streptococci in 42 per cent of cases.

4. Bile has been shown to inhibit the growth of this streptococcus.

5. The cystic gland in cases of cholecystitis has been shown to yield a growth of streptococcus in 86 per cent of cases.

6. *Bacillus coli* was recovered from the bile in only 6 per cent of cases. In the one case in which this organism was recovered from the cystic gland contamination by bile could not be excluded.

7. The streptococcus of cholecystitis is a short-chained type, produces smooth non-hæmolytic colonies on agar, and grows readily on glucose broth.

8. Injections of saline suspensions of this organism into the lumen of rabbits' gall-bladders produced no change.

9. Intramural injections of streptococci into rabbits' gall-bladders produced a progressive chronic cholecystitis, from which the organism was readily recoverable.

10. With the cystic duct ligated, intramural injections produced a chronic empyema with marked intramural changes.

11. Small calculi were produced with both types of intramural injection. When the cystic duct was ligated the calculi contained calcium and cholesterin; when the cystic duct was patent cholesterin only.

12. Intravenous injection of the streptococci, when repeated, produced a progressive chronic cholecystitis with the formation of cholesterin stones.

13. Intravenous injection after the ligation of the cystic duct produced an empyema of the gall-bladder with marked intramural changes and formation of granule-like calculi containing both calcium and cholesterin.

14. Separation of the gall-bladder from the liver, with interpolation of the omentum to exclude infection by lymph-spread from the liver, along with ligation of the cystic duct, did not prevent the development of cholecystitis when streptococci were injected intravenously.

15. The intramural pathological changes produced experimentally resemble in every detail the changes seen in the human gall-bladder in cholecystitis.

16. Cholecystitis would appear, therefore, to be a blood-borne streptococcic intramural infection.

I wish to express my thanks to Professor D. P. D. Wilkie, at whose suggestion and under whose guidance this work was carried out, and to Professor Edward Archibald, of McGill University, who granted and arranged my leave of absence from his service. I must also acknowledge the assistance rendered by the members of the technical staff of the Department of Experimental Surgery, University of Edinburgh.

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THE RESULTS OF SPLENECTOMY FOR PURPURA HÆMORRHAGICA.

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The operation of splenectomy in the treatment of purpura hæmorrhagica was performed for the first time in 1916 by Kaznelson,[38] who argued that the hæmorrhages were the result of the constant reduction in the number of blood platelets, or thrombocytes, and that this reduction was brought about by the destructive action of a diseased spleen. He suggested the name 'thrombocytolytic purpura'. Frank[26] also advised splenectomy, but on different grounds—namely, that the reduction in platelets was due to an inhibitory action of the spleen on the bone-marrow, and for this reason called the disease 'essential thrombopenia'. As pointed out by Koster,[43] experimental evidence favours Kaznelson's view: "Were the platelets not formed in sufficient numbers, the amount of thromboplastic substance furnished to the blood by their destruction would be insufficient to cause prompt coagulation. The coagulation time, however, in this disease remains normal". Following in the wake of Frank and Kaznelson, many observers have performed splenectomy in the treatment of purpura hæmorrhagica, and have reported good results accruing therefrom. It is thought advisable, therefore, to report the following two cases in which splenectomy was performed: the one, in which there was no recurrence of hæmorrhages after a period of eight months; the other, in which splenectomy had no effect on their occurrence.

CASE REPORTS.

Case 1.—P. C., female, age 6, developed suddenly on Feb. 10, 1926, a purpuric eruption on the forehead, behind the ears, and on the trunk and limbs. The urine was bright red for three days, and she bled slightly from the ears. There was no disturbance of the general health. Three days later she had sudden and severe pain in the outer side of the right ankle, and four days after this she was admitted to the local hospital with a severe epistaxis, which lasted for three days. The pain in the leg proved to be due to acute osteomyelitis; the region was incised and pus evacuated; the sequestrum was discharged at the end of March, and the wound healed by the middle of June, 1926.

During the first week in May, 1926, there was a recurrence of the purpuric eruption, and petechiæ appeared in crops during May, June, and July. The distribution was as before, but there were also small hæmorrhages under the mucous membrane of the tongue and mouth. On Aug. 5 she had a mild epistaxis.

Admission.—The patient was admitted into St. Bartholomew's Hospital on Aug. 6. She had always bruised easily since February, 1926. Her general health was good; there was no history of arthritis, abdominal pain, or melæna. There was no history of previous hæmorrhages; nor a family history of hæmophilia or purpura.

On Examination.—There was a petechial rash over the trunk and limbs, and ecchymotic patches on the back and legs; there were petechiæ under the mucous

membrane of the mouth, and the mucous membrane around the teeth was vascular in places. The tonsils were enlarged, reddened, and had an active appearance; the tonsillar glands were enlarged; there were enlarged glands in the posterior triangles of the neck, in the axillæ, and groins. The heart and lungs were normal. The liver was palpable one finger-breadth below the right costal margin. The lower pole of the spleen was palpable on inspiration; it was firm and not tender. No hæmorrhages were seen in the fundi. There was no blood in the urine. The red blood-cells numbered 5,170,000 per c.mm.; hæmoglobin 70 per cent, making a colour index of 0·7. The white cells were 5200—of these, neutrophil polymorphonuclears, 3900; lymphocytes, 1090; large mononuclears, 155; eosinophil polymorphonuclears, 55. Blood platelets, 6450. Bleeding time, more than 30 min. (control, 2½ min.); coagulation time, 2 min. 17 sec. (control, 2 min. 15 sec). Wassermann and Sigma reactions were negative. A skiagram of the right fibula showed the presence of osteitis, but no sequestra.

At this time the case was considered to be an example of secondary purpura rather than of an 'idiopathic'. The primary foci suspected were the ankle-joint, although clinically it appeared perfectly sound, and the infected tonsils. On these grounds, therefore, it was decided to remove the tonsils, and in an attempt to lower the bleeding time in preparation for this, 15 gr. of calcium lactate were administered by the mouth three times daily. The petechiæ and ecchymoses, however, continued to appear, and on one occasion there was blood in the stools. After a month's treatment with calcium lactate, the patient was given 10 c.c. of horse serum subcutaneously on two occasions, still with no effect on the appearance of petechiæ and ecchymoses. The blood-count on Sept. 21 was: red blood-cells, 3,900,000; hæmoglobin, 68 per cent; colour index, 0·9; white blood-cells, 7200.

On Oct. 6 the patient was transfused with 50 c.c. of citrated blood: the bleeding time after this fell to 6 min. 40 sec. (control, 2 min. 10 sec.). On the following day tonsillectomy was performed, but the hæmorrhage was so great that only one tonsil could be removed; bleeding from the tonsillar bed continued for one and a half hours. The patient was discharged after three weeks, during which time she continued to have epistaxis and bleeding from the gums.

Second Admission.—She was re-admitted on Nov. 2, 1926. During the first week there were three days on which she had severe epistaxis. The spleen was easily palpable. Examination of the blood gave the following results: red cells, 4,150,000; hæmoglobin, 55 per cent; colour index, 0·66; white cells, 9600—polymorphonuclears, 6672; lymphocytes, 1968; large mononuclears, 672; eosinophils, 288; platelets, 20,750; coagulation time, normal; bleeding time, 11½ min. (control, 3 min.).

On Nov. 24 the patient was transfused with 275 c.c. of citrated blood. Before transfusion the bleeding time was 5 min. 45 sec. (control, 1 min. 10 sec.); twenty-four hours after transfusion the bleeding time had fallen to 2 min. 30 sec. (control, 1 min. 15 sec.); the platelets had risen to 138,900; red cells, 4,630,000; white cells, 8600. Removal of the remaining tonsil was effected with practically no hæmorrhage at all. Forty-eight hours after transfusion the bleeding time had fallen to 1½ min. (control, 1 min.), and the platelets had risen to 173,200. Four days after transfusion, however, the bleeding time had risen to 14 min., and the platelets had fallen to 123,700; there was slight bleeding from the gums and lips during the night. After this there was no more bleeding, and the patient was discharged on Dec. 8 with a bleeding time of 14½ min., platelet-count, 154,300.

Third Admission.—On Jan. 21, 1927, the child was admitted again with nose-bleeding and bruising. On examination she looked well; the tonsillar fossæ were clear. There were two large recent ecchymoses, one on the right forearm, one over the left great trochanter; there were many purpuric spots in all stages over the chest and abdomen; several old bruises were over both legs. The spleen was not palpable. Red cells numbered 4,580,000; hæmoglobin, 61·8 per cent; colour index, 0·68; white cells, 6200; platelets, 45,800; bleeding time, 15½ min. (control, 1 min. 15 sec.).

As no foci of infection were found, the previous foci having been treated successfully, and as the bleeding still continued, with constant diminution of platelets and

prolongation of the bleeding time, the case was considered one of essential thrombocytopenic purpura hæmorrhagica, and it was decided to perform splenectomy. On Jan. 31 the patient received a transfusion of 250 c.c. of citrated blood into the right internal saphenous vien. Eighteen hours after transfusion the platelets had risen to 115,200 and the bleeding time had fallen to 1¼ min. (control, 1 min.).

Operation.—On Feb. 1 splenectomy was performed by Professor Gask; the abdominal incision was attended by a good deal of bleeding, which was controlled with forceps; a splenunculus was found to be present, but was not removed. The platelet count two days after splenectomy had risen to 203,600; the bleeding time was 2 min. 7 sec. (control, 1 min.); red cells, 4,480,000; white cells, 7200—of these, polymorphonuclears, 3888; lymphocytes, 2016; large mononuclears, 1080; eosinophils, 36; basophils, 36; myelocytes, 36; abnormal vacuolated lymphocytes, 108.

The platelet-count showed the rise above normal which has been reported by several authors; on Feb. 7 the platelets were 344,600, and the bleeding time was 45 sec. On Feb. 17 they had fallen to 283,000, and the bleeding time to 40 sec.: red cells, 5,940,000; white cells, 10,000—of these, polymorphonuclears, 5750; lymphocytes, 2600; large mononuclears, 700; eosinophils, 450; transitional myelocytes, 450; myelocytes, 50.

After-history.—The patient made an uninterrupted recovery, and eight months after the operation felt quite well and had had no hæmorrhages whatsoever. Four and a half months after operation there was, however, a slight flare-up of her osteomyelitis, which contributed probably to the leucocytosis which was found. The bleeding time at this period was 1 min. 7 sec. (control, 1 min.); platelets, 243,000; red cells, 4,860,000; white cells, 31,400—polymorphonuclears, 22,137; lymphocytes, 5338; large mononuclears, 3140; eosinophils, 785. Eight months after splenectomy the bleeding time was ¾ min. (control, ¾ min.); platelets, 400,000; red cells, 4,810,000; white cells, 14,000—polymorphonuclears, 7280; lymphocytes, 4830; large mononuclears, 770; eosinophils, 770; transitional, 210; basophil myelocytes, 140.

Pathological Report.—Mr. Geoffrey Keynes reported that the spleen which was removed at operation was somewhat enlarged: weight 117 grm. (4⅛ oz.). On section the lymphoid nodules appeared somewhat exaggerated, and contained large germinal centres of endothelial cells. There was an increase of the endothelial reticulum throughout, with diminution of lymphoid cells.

Case 2.—J. L., male, age 23, a clerk, had an attack of malaise, feverishness, and giddiness at Christmas, 1926; he was in bed for one day, and had a fairly severe epistaxis which lasted for two hours. Two months later a tooth was extracted, and the bleeding was so profuse as to necessitate plugging. Soon after this he became increasingly pale, weak, and short of breath on exertion; he had two or three slight epistaxes.

Admission.—On April 30, 1927, the patient was admitted to St. Bartholomew's Hospital, complaining of increasing languor, dizziness, shortness of breath, and throbbing pains in the head. There was no history of respiratory or digestive disturbance, or of blood in the stools or urine; no history of previous hæmorrhages nor a family history of bleeding.

On Examination.—The patient's expression was anxious, his skin and mucous membranes were very pale, with a very slight icteric tinge. There were small purpuric spots on the right arm, right shoulder, and front of the chest, and a few irregularly shaped hæmorrhages in both retinæ. The tongue was clean, there was no gingivitis, and no hæmorrhages into the gums. The tonsils were slightly enlarged, but did not look septic; there was a little blood-clot at the back of the pharynx, but no obvious bleeding-point. The lungs were normal. The heart was over-acting, and a hæmic murmur was heard in the pulmonary area. The blood-pressure was 125 systolic, 75 diastolic. The liver and spleen were not palpable. There was no albumin or blood in the urine, and no blood in the fæces.

The red blood-cells numbered 1,337,000; hæmoglobin, 28 per cent; colour

index, 1·1 ; there were 2600 leucocytes—of these, polymorphonuclears, 845 ; lymphocytes, 1667 ; large mononuclears, 52 ; and myelocytes, 26 ; one normoblast was seen. There was marked anisocytosis and poikilocytosis, polychromatophilia, and hypochromasia ; there was no punctate basophilia. Blood platelets, 38,000. The bleeding time was more than 12 min. (control, 2 min. 43 sec.), and the coagulation time 1 min. 20 sec. (control, 1 min. 39 sec). Van den Bergh reaction on blood serum : direct, negative ; indirect, 0·33 units. A fractional test-meal was normal and showed no hypochlorhydria.

On May 5 the patient had a severe epistaxis. The anterior nares were plugged with gauze soaked in 1–1000 adrenalin, and 3 c.c. of hæmoplastic serum and $\frac{1}{4}$ gr. of morphia were given subcutaneously. He bled for five hours and lost about 600 c.c. of blood. The blood-count was : red cells, 1,169,000 ; hæmoglobin, 23 per cent ; colour index, 1·0 ; white cells, 2600. Differential : polymorphonuclears, 468 ; lymphocytes, 1950 ; large mononuclears, 156 ; myelocytes, 26. Owing to his severe anæmia he was given liq. arsenicalis hydrochlor. (3 minims) with an iron mixture containing 8 gr. of iron and ammonium citrate three times daily, and this was increased gradually until in three weeks he was taking 8 minims of the liquor daily.

On May 6 another profuse epistaxis occurred ; the patient also vomited 16 oz. of clotted blood, which had probably trickled into his stomach from the nasopharynx. He was given 20 gr. of calcium lactate orally three times daily and transfused with 550 c.c. of citrated blood. On May 7 he was transfused with 450 c.c. of citrated blood. This was followed two hours after by a rigor, and the temperature rose to 103·2°, but fell again to normal by evening.

On May 12 a crop of petechiæ appeared on the right upper arm and chest. Blood-count : red cells, 1,659,000 ; hæmoglobin, 33 per cent ; colour index, 1·0 ; white cells, 1800. Differential : polymorphonuclears, 288 ; lymphocytes, 1386 ; eosinophils, 18 ; large mononuclears, 72 ; myelocytes, 36. No normoblasts. Blood platelets, 38,000. Small crops of petechiæ continued to appear during the next four weeks.

On May 17 the red cells were 1,653,000 ; hæmoglobin, 33 per cent ; colour index, 1·0 ; white cells, 1900. Differential : polymorphonuclears, 342 ; lymphocytes, 1502 ; large mononuclears, 57 ; platelets, 8250.

On May 25 the red cells were 1,680,000 ; hæmoglobin, 35 per cent ; colour index, 1·03 ; white cells, 1600 ; platelets, 6800. The coagulation time was 1 min. 20 sec. (control, 1 min. 39 sec.) ; bleeding time more than 12 min. (control, 2 min. 42 sec.).

The administration of iron and arsenic alone had obviously failed to promote hæmoglobin and red-cell formation. On May 28, as a further attempt to effect this, the patient was put on a diet of 6 oz. of cooked liver daily, with excess of green vegetables and increased fat in the form of butter. On May 31 the red cells were 1,825,000 ; hæmoglobin, 31·5 per cent. On June 2 hæmoglobin, 28·5 per cent. On June 8 red cells, 1,536,000 ; hæmoglobin, 28·5 per cent.

No focal sepsis had been found ; the tonsils appeared free from infection ; the ears were normal ; stool culture failed to reveal any hæmolytic coliform bacilli ; one colony only of hæmolytic staphylococci was grown. This being the case, and as the bleeding time was greatly prolonged, the coagulation time normal, and the platelets considerably diminished, the diagnosis of idiopathic purpura hæmorrhagica was made.

Operation.—On June 11 the patient was transfused with 400 c.c. of citrated blood, and on the 15th splenectomy was performed by Mr. R. M. Vick. The operation was accompanied by a large amount of bleeding, which was controlled with difficulty ; there was no diminution of bleeding after the splenic vessels had been clamped, a phenomenon which has been reported by several authors. During the latter stages of the operation the patient received a transfusion of 600 c.c. of citrated blood.

After-history.—After splenectomy there was some improvement. On June 18 the platelets numbered 45,000. On June 22 the red cells were 2,000,000 ; hæmoglobin, 28 per cent ; platelets, 96,480 ; but on the same day a profuse epistaxis

occurred. On the 28th the red cells had fallen to 1,570,000, the hæmoglobin being 32 per cent ; platelets, 47,000. On Aug. 7 the platelets were 48,000, and the bleeding time had fallen to 4 min. 25 sec. (control, 3 min. 28 sec.).

On July 30 the administration of iron and inorganic arsenic was discontinued, and on Aug. 7 organic arsenic was given in the form of ¾ gr. of sodium cacodylate subcutaneously twice daily. There was no improvement in the blood picture ; slight attacks of epistaxis and the appearance of petechiæ continued, and on Aug. 13 there was a large hæmorrhage into each retina. The patient was transfused again with 550 c.c. of citrated blood, but without improvement : the red cells numbered 1,200,000 ; hæmoglobin, 30 per cent ; platelets, 16,000. On Aug. 25 there was bleeding from the gums for three hours, and on the 27th another transfusion of 550 c.c. of citrated blood was given. On the 28th acute tonsillitis ensued which was treated with an autogenous vaccine. The patient is still (Oct. 12, 1927) in hospital with occasional bleeding from the gums, slight attacks of epistaxis, and crops of petechiæ.* On Sept. 28 the red cells were 1,570,000 ; white cells, 1800 ; platelets, 43,600 ; and bleeding time was more than 15 min. (control, 1 min.).

Pathological Report.—Dr. Conway Davies reported that the spleen which was removed at operation was somewhat enlarged. On section it appeared normal. Microscopically, it was normal except for hyaline degeneration in the walls of the arteries ; there was no endothelial proliferation and no increase of the lymphoid nodules. In a smear of the cut surface of the spleen there were 200,000 platelets per c.mm.

DIAGNOSIS.

Purpura may be produced by such a large number of causes that all of these must be eliminated before a definite diagnosis of purpura hæmorrhagica is made. Prolongation of the bleeding time, diminution of the platelet-count, and normal coagulation time occur in secondary purpura as well as in primary, so that all foci of infection should be carefully hunted for, and the condition considered a secondary purpura until this is definitely disproved. In *Case* 1 the appearance of purpuric spots was more or less synchronous with the onset of osteomyelitis of the right fibula, and it was thought at first that the continuation of purpuric symptoms might be due to some remaining sepsis in this bone. Moreover, the tonsils were infected, and the occurrences of hæmorrhages after the leg appeared clinically sound caused suspicion to be centred on them. These were consequently enucleated, but still hæmorrhages continued, although all foci of infection had been removed. On these grounds, therefore, the case was considered one of essential thrombocytolytic purpura hæmorrhagica.

The diagnosis of *Case* 2 was for some time in doubt. Diminution of blood platelets does not label a condition one of purpura hæmorrhagica, as considerable diminution occurs in pernicious anæmia, aplastic anæmia, and lymphatic leukæmia,[18] though not perhaps to such a marked degree. In this case there was severe anæmia, leucopenia with relative lymphocytosis, and

* The patient died in November 1927, while this paper was in the press. At autopsy, the pericardial sac contained 4 oz. of clear serous fluid. There were many hæmorrhages under the parietal and visceral pericardium. The heart muscle showed marked fatty degeneration. Each pleural cavity contained 6 oz. of clear serous fluid ; there were dense adhesions between the upper and middle lobes, and a few subpleural hæmorrhages were present. Both lungs were extremely œdematous, and were studded throughout with small intrapulmonary hæmorrhages. The liver showed fatty degeneration and a feeble Prussian-blue reaction. The kidneys were fatty, and the Prussian-blue reaction was negative ; both pelves showed areas of extensive hæmorrhages. The bone-marrow from the middle of the shaft of the left tibia was extremely pale ; the Prussian-blue reaction was negative.

an absolute decrease of polymorphonuclears, and a considerable diminution of platelets. The question arose whether it was an example of aplastic anæmia or purpura hæmorrhagica; there is no definite dividing line between the two conditions, but the one runs imperceptibly into the other. The deficiency of platelets is supposed to account for the hæmorrhagic tendency shown in aplastic anæmia. Of myelophthisic conditions giving rise to such a blood picture, Frank[25] recognizes three degrees:—

1. *Intermittent thrombopenia*, in which there are occasional recurrent attacks of hæmorrhages. It occurs mainly in children, and includes those conditions variously known as peliosis rheumatica, Henoch's purpura, etc. Frank states that before the onset of the hæmorrhages there is a diminution in the platelet-count, though between the attacks it is normal.

2. *Essential thrombopenia, or purpura hæmorrhagica*, in which there is always a continuous reduction of platelets, usually an anæmia, and often a leucopenia of varying degree with diminution in polymorphonuclears both relative and absolute.

3. *Aleukia hæmorrhagica, or aplastic anæmia*, in which the anæmia and leucopenia of (2) are accentuated.

It cannot be said definitely that this is a case of purpura hæmorrhagica, but the simultaneous occurrence of the marked prolongation of the bleeding time, the considerable diminution in the number of platelets, and the normal coagulation time favours this view.

MORBID ANATOMY OF THE SPLEEN.

The findings in *Case* 1 agree with those of most observers, who have found that the majority of spleens removed from patients with purpura hæmorrhagica show hyperplasia of the endothelial phagocytes. In the present review the reports of twenty-seven of such spleens are collected. The spleens in most cases are enlarged to two or three times their normal size and contain a large amount of blood. On the whole, the most striking changes are marked endothelial proliferation of the Malpighian bodies and sinuses. There is an increase in the number of reticular cells in the sinuses and throughout the entire organ. In some cases there is an infiltration of polymorphonuclears and eosinophils. The number of lymphoid cells varies; it may be normal, increased, or diminished.

Hitzrot[37] has reported a case in which the arteries in the follicles showed almost uniformly a thickening and hyaline degeneration of the wall and narrowing of the lumen; in *Case* 2 here reported there was similar hyaline degeneration in the walls of the arteries. In two cases published by Sutherland and Williamson,[73] in addition to endothelial proliferation, the connective tissue of the sinuses was swollen and hyaline, and the lymphocytes were greatly diminished. Most observers could find no collections of platelets, but Benecke,[7] Cori,[15] Giffin,[28] and Minkowski[53] have each reported cases in which many platelets were in evidence—many were present in a smear of the spleen in *Case* 2 of this paper. In one of Sutherland's cases,[73] a lymph gland removed from the mesentery at the time of operation showed also marked endothelial proliferation. Giffin and Holloway,[29] in a review of twenty-eight cases, found nothing of outstanding importance, except the presence of an

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abnormally large number of neutrophil polymorphonuclears. They suggest that the splenomegaly of purpura hæmorrhagica is an acute splenitis.

THE RELATION OF PLATELETS TO THE BLEEDING TIME.

By studying the behaviour of the bleeding time in *Case* 1, it will be seen that its decrease or increase is associated with the rise or fall of the platelets, and from this it may be concluded that the tendency to prolonged bleeding is due, at least in part, to the deficiency in platelets. Duke[19] has shown that a diminution in the platelet-count is associated with prolongation of the bleeding time, though the actual clotting time remains normal. Sutherland and Williamson[73] state that when the platelets reappear in sufficient number in the blood, for instance, after splenectomy, the bleeding time becomes normal. From a survey of the literature, however, I have found that diminution in the number of platelets is not necessarily associated with prolongation of the bleeding time (*Table I*). It may be argued that the platelets in *Group A* of the table are in sufficient numbers for the bleeding time to be normal, but

Table I.—Relation of Platelets to the Bleeding Time.

No. of Case in Abstract	Time after Operation	Platelets	Bleeding Time
Group A.—**Platelets diminished and bleeding time normal after splenectomy.**			
1	4½ months	60,000	1 min.
4	11 weeks	12,000	3 ,,
5	2 hours	31,200	3 ,,
5	6 weeks	12,000	3 ,,
9	8 months	20,000	2 ,,
9	14 months	120,000	2 ,,
11	15 hours	109,000	3 ,,
41	1 day	20,000	½ ,,
49	18 days	88,000	2½ ,,
93	10 months	20,000	Normal
6	2 days	80,000	3 min.
97	6 days	100,000	1½ ,,
Group B.—**Platelets normal or increased, bleeding time increased.**			
9	10 months	200,000	16–20 min.
24	(Before splenectomy)	284,000	33 ,,
34	" After operation "	600,000	5 ,,
50	5 days	516,000	7½ ,,
60	8 days	250,000	5 ,,
88	3 days	Normal	7 ,,

Table II.—Platelets and Bleeding Time in Pernicious Anæmia. (After Buckman and Hallisey[10]).

Platelets	Bleeding Time
32,000	3¼ min.
172,000	3¼ ,,
160,000	4¾ ,,
101,000	1¼ ,,
171,000	2¼ ,,
53,000	3 ,,
110,000	2½ ,,
97,000	3¼ ,,
148,000	3 ,,

on the other hand from the abstract of 101 cases given in the APPENDIX (*see* p. 480) it will be seen that a greater number of platelets than those in *Group A* may be associated with a prolonged bleeding time.

In *Group A* of *Table I* the platelets are diminished and the bleeding time is normal, and no hæmorrhages occurred after splenectomy in these cases except in No. 8. Moreover, in pernicious anæmia there is a diminution in the number of platelets, and yet the bleeding time is normal or but very slightly prolonged (*Table II*). Further, Roskam[66] has shown experimentally that in animals in which a marked reduction of the platelet-count had been produced by the intravenous injection of a solution of gelatin, the bleeding time was only slightly prolonged. In *Group B* of *Table I* there are cases in which there is a normal or an increased number of platelets, and yet the bleeding time is prolonged. These facts seem to show that prolongation of the bleeding time is probably dependent on something more than platelet reduction, perhaps on a qualitative defect in the platelet itself. This aspect of the problem requires further investigation. In support of this view that abnormal platelets may be the cause of prolonged bleeding time, Rockwood and Sheard[64] have demonstrated in purpura hæmorrhagica by instantaneous microphotography a structural change in the platelets which is not demonstrable in other diseases, such as pernicious anæmia.

THE EFFECT OF CITRATED BLOOD ON THE BLEEDING TIME AND PLATELETS.

The status of blood transfusion was discussed a few years ago in an editorial of the *Journal of the American Medical Association*,[20] in which the writer concludes that citration of the blood causes destruction of blood platelets, that sodium citrate has, in itself, a toxic effect, and that the giving of citrate in transfusion lowers the hæmostatic power of the circulation. These statements are supported by Herr,[35] who says that the citrate solution destroys the platelets, which are necessary for maintaining the blood at its highest efficiency, and that as the platelets are destroyed, toxic by-products are liberated into the plasma with deleterious after-effects. Burke and Tait[11] consider that the only blood elements concerned in the spontaneous coagulation of mammalian blood are the platelets. Gichner[27] has shown that platelet-free mammalian plasma will not spontaneously clot under circumstances that cause coagulation of platelet-rich plasma, that sodium citrate in sufficient concentration inhibits their activity completely, but that if sufficient concentration of a calcium salt is added, or the concentration of citrate is sufficiently lessened, platelets behave as in unmodified blood, thus refuting the above statement that platelets are destroyed by citrate. Gichner, however, in two cases of pernicious anæmia and three of secondary anæmia, in which transfusion of citrated blood was performed, was unable to find any marked rise or fall in the platelet-count as a result.

In *Case* 1 of this paper transfusion with citrated blood was performed on three occasions : on the first with 50 c.c. of blood containing 1 grm. of sodium citrate, on the second and third with 275 c.c. and 250 c.c. respectively, each amount containing 2 grm. of sodium citrate. On the first occasion the bleeding time four days before the transfusion was more than 30 min. ; eight

days after, the bleeding time had fallen to 6 min. 40 sec.; the platelets were not counted. Before the second transfusion the platelets numbered 20,750, and the bleeding time was $5\frac{3}{4}$ min.; twenty-four hours after the transfusion, the platelets were 138,900, bleeding time $2\frac{1}{2}$ min.; forty-eight hours after, the platelets were 173,200, bleeding time $1\frac{1}{2}$ min.; four days after, however, the platelets were 123,700, bleeding time 14 min. Before the third transfusion the platelets were 45,800, and bleeding time was $15\frac{1}{2}$ min.; eighteen hours after, the platelets were 115,200, bleeding time $1\frac{1}{4}$ min. (*Fig.* 361). This

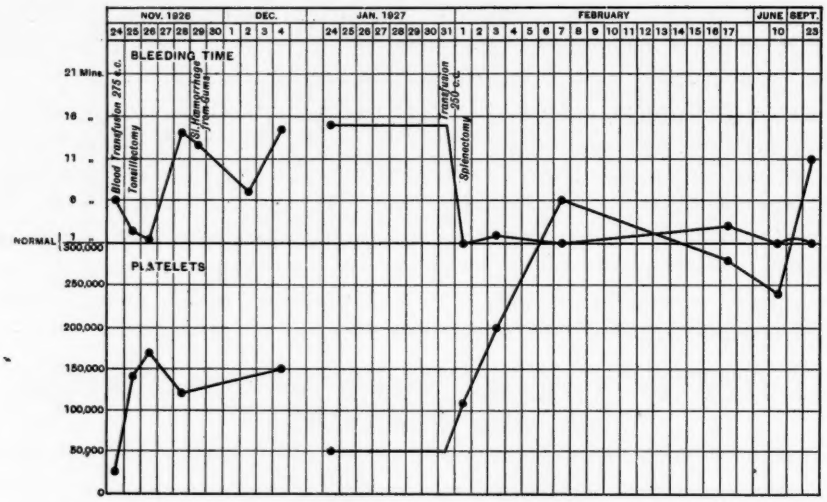

FIG. 361.—Chart showing the effect of blood transfusion and splenectomy on the bleeding time and platelet-count in purpura hæmorrhagica (*Case* 1).

disproves the statement that platelets are destroyed by citrated blood and that the hæmostatic power of the blood is reduced by citrate. It seems that transfusion acts as a temporary stimulus to the megakaryocytes of the bone-marrow to increased platelet production, but that after three or four days this stimulating effect disappears, with consequent diminution of the platelet-count and prolongation of the bleeding time.

In *Case* 2 repeated blood transfusions were performed with no effect on the blood picture whatsoever, a possible explanation being that the marrow was too diseased to respond.

THE EFFECT OF SPLENECTOMY.

Case 1 illustrates the beneficial effect of splenectomy in this disease which has been reported by many writers. Immediately after operation there was cessation of hæmorrhages, with no recurrence for eight months; the bleeding time fell to normal and has remained so; the platelets rose gradually to a high level, and six days after the operation were above normal; the high platelet-count was maintained, and eight months after was well above normal. In *Case* 2 the result of splenectomy was poor. There was some slight improvement, for after the operation the patient did not have the severe attacks of epistaxis from which he suffered previously, but bleeding still continued as

crops of petechiæ, slight attacks of epistaxis, and hæmorrhages from the gums and into the retinæ. The platelets rose a little after the operation and the bleeding time fell to 4½ min., but this improvement was not maintained.

From the analysis of 101 published cases (*see* p. 480) of purpura hæmorrhagica in which splenectomy was performed, it is found that a good result with no recurrence of hæmorrhages occurred in 69, and in 6 cases there was considerable improvement; 21 died after operation, while in 5 the hæmorrhages continued with but slight improvement. Of the 75 cases in which the result was good, 16 were not followed up for any considerable period, so that little value can be attached to these. Of the 21 fatal cases, 17 died as the result of severe bleeding: in Corpus' case (No. 13) there were hæmorrhages into the endocardium, pericardium, and stomach; in Engel's (No. 17) into the skin and serous cavities; in Engel's second case (No. 18) there were hæmorrhages into the gastro-intestinal tract, genito-urinary tract, and heart; in Herrman's case (No. 33) there were subcutaneous, subserous, and parenchymatous hæmorrhages; in one of Kaznelson's (No. 38) marked degeneration and bleeding into the myocardium; in two cases, Peterson's (No. 62) and Singleton's (No. 78), there was cerebral hæmorrhage; and in Starr's (No. 81) massive clots were found over both cerebral hemispheres beneath the dura. Four cases died of causes other than those due to purpura hæmorrhagica: one death was accidental during operation; in Cori's case (No. 12) malarial parasites were found in the blood, and death occurred from subphrenic abscess one month after operation; Henrahan's case (No. 31) died one month after operation, and at autopsy abscesses were found in the lungs, myocardium, and kidneys; Rixford's case (No. 66) developed acute myeloid leukæmia two months after operation, and died two months later.

The histories of these 101 cases show that purpura hæmorrhagica may be divided into the acute and the chronic type (*Table III*), the chronic being much more common than the acute: there were 80 chronic, 12 acute, and 9 cases in which the duration of the hæmorrhages was not stated. Out of the 12 acute cases 10 died, but of the chronic only 8, one being due to an accident and 3 to causes other than purpura hæmorrhagica; in 5 of the chronic the result was poor. Thus it appears that splenectomy is much more suitable for the chronic type of case than the acute.

Table III.—Results of Splenectomy in 101 Cases of Purpura Hæmorrhagica.

Results	Acute	Chronic	Unclassified	Total
Good results				
No recurrences	2	61*	6†	69
Improvement	—	6	—	6
	Per cent 16·6	Per cent 80·9‡		
Poor results	—	5	—	5
Deaths	10	8	3	21
	Per cent 83·3	Per cent 11·8‡		Per cent 20·8
Total cases	12	80	9	101

* 12 cases with no follow up. † 4 cases with no follow up. ‡ Excluding those not followed up.

The effect of splenectomy on the platelet-count varies considerably. In 61 cases there was a great increase, the count rising to normal in 25, and above normal in 36, but in 35 of these 61 cases counts were not made over a period of more than three months after splenectomy, so that it is impossible to say what happened ultimately. In 11 of these 35 which were not followed up, however, the count had fallen from above normal to normal by the end of three months. Of the 26 cases which were followed up, in 10 the platelet-count remained normal over a considerable period, and in 16 the platelets fell gradually so that there was again a thrombocytopenia. In those in which a high count was maintained no hæmorrhages occurred, with one exception, Keisman's case (No. 40), in which the result was poor in spite of the normal platelet-count. Of the 16 in which an initial rise was followed by a thrombocytopenia, 11 had no recurrence of hæmorrhages, 1 improved, in 1 the result was poor, and 3 (Nos. 12, 47, and 78) died. In 17 cases splenectomy was followed by little or no increase in platelets, and of these 7 (2 of which were not followed up) had no recurrence of hæmorrhages, 2 were improved, 2 continued to bleed, and 5 died. Thirteen cases died before any investigations were made, and in 12 there were no details. In all cases, except those mentioned in *Table I*, the rise or fall in platelets was associated with a fall or rise in the bleeding time.

The blood picture after splenectomy shows, according to Noguchi,[59] a diminution in polymorphonuclears and a lymphocytosis during the first year; later the lymphocytes fall to normal and there is an eosinophilia; and later still the count is normal. Of the two cases published in this paper the first showed a rise in erythrocytes sixteen days after the operation and a subsequent fall to normal; there was a moderate leucocytosis with an increase in all cells, but four and a half months after, the leucocytosis had become considerable owing to a great increase in polymorphonuclears, which was accounted for by the recurrence of osteomyelitis. Eight months after, the leucocytosis was again moderate, the increase being general. In *Case* 2 there was no marked change in the blood picture except for a slight temporary rise of erythrocytes. Thursfield and Gow,[74] from an analysis of 100 cases of splenomegaly from which the spleen was removed, conclude that the immediate result is an increase in erythrocytes and a leucocytosis which returns gradually to normal, there only being a tendency to the findings of Noguchi. From the present review the conclusion is similar: splenectomy is followed by an immediate rise of erythrocytes and a leucocytosis with a normal proportion of cells, followed in most cases by a very gradual fall.

The questions arise why some cases are benefited by splenectomy and others are not; and why in some cases splenectomy causes a permanent increase in platelets, in others an increase followed by a decrease, and in others no increase at all. They can be answered only by a study of the pathogenesis of the condition. The constant decrease in platelets suggests that they play a part in the causation of the hæmorrhages, and Duke[19] expressed the view that the essential factor in primary purpura is an abnormal permeability of the endothelium of the small vessels, and that the function of the platelets is to adhere to such permeable sites, and prevent the escape of blood. In so doing the platelets are withdrawn from the circulation. Tidy[75] considers

that the deficiency of platelets may be due directly to the bone-marrow not replacing sufficiently the losses due to hæmorrhage, and concludes that reduction in the number of platelets is a secondary phenomenon. Were this the case, one would expect them to be reduced in secondary anæmias. Crawford,[18] however, states that the platelet-count in secondary anæmias is normal or increased, and this agrees with the findings of Buckman and Hallisey.[10] Moreover, from the blood-counts in purpura hæmorrhagica (*Table IV*), it is evident that the diminution in platelets far exceeds the diminution in red cells—a state of affairs which one would not expect were the thrombocytopenia due to a secondary exhaustion of the bone-marrow. From this it appears that the diminution of platelets is not a secondary phenomenon, but a primary factor in the causation of the disease.

Table IV.—Blood-count in Purpura Hæmorrhagica.

Case No.	Hb%	R. B. C. (in thousands)	Platelets	Case No.	Hb%	R. B. C. (in thousands)	Platelets
1	60	5,200	11,000	59	60	6,504	60,000
12	40	4,200	2,700	60	55	5,584	0
17	76	4,500	0	65	78	4,940	70,000
23	55	4,400	62,000	79	70	5,170	6,450
29	?	4,200	Few	83	87	4,620	62,600
33	61	3,700	30,000	84	85	4,120	36,000
37	120	5,500	6,700	85	50	5,300	18,000
52	73	4,480	52,000	86	45	5,200	5,000
54	60	4,500	3,000	89	75	4,000	Very few
55	56	5,200	14–29,000	96	65	4,200	0
58	42	4,980	0	97	75	4,400	5,000

Ledingham and Bedson[47] have produced in guinea-pigs by the injection of anti-guinea-pig-platelet serum a condition resembling purpura hæmorrhagica, but sera prepared against other blood elements were unable to produce purpura. The characteristic feature in the purpuric animals was the early and extensive fall in the number of platelets; sera other than anti-platelet sera produced little or no change in this respect. Bedson[3] has shown, however, that reduction of platelets is not the only factor. By injecting intravenously into guinea-pigs substances such as 'agar serum' or peptone he produced a considerable, though transitory, fall in the platelet-count, and yet there were no hæmorrhages. He suggested that the second factor was damage to the capillary endothelium, and he reasoned that if this was so, then it should be supplied by any of the sera prepared against the blood elements, since they are all more or less closely related genetically to the endothelial cell. Anti-red- and anti-white-cell sera were unable to produce purpura, presumably because they did not remove the platelets from the circulation; anti-platelet serum effected it because it is in anti-platelet serum alone that the two factors are combined. When anti-red-cell serum was inoculated into a rabbit to damage the endothelium, and shortly afterwards agar serum to remove the platelets, purpura was produced, the post-mortem findings being similar to those produced by anti-platelet serum. If the function of platelets is to

adhere to any permeable site in the vessel wall and prevent the escape of blood, damage to the endothelial wall will not cause purpura, because the platelets conglutinate over the damaged area and block the stoma. When both platelets and endothelium are affected, there are not sufficient platelets to block all the stomata, and hæmorrhages result.

It has been shown (Bedson and Johnston[6]; Alrutz, Norbell, and Piette[1]) that in all probability one of the functions of the spleen is the destruction of blood platelets. In some cases of purpura hæmorrhagica in which splenectomy has been performed, after the preliminary increase in the number of platelets, there is a fall to normal, and later the diminution continues until the thrombocytopenia is almost as severe as before splenectomy. This is suggestive that the function of destruction of platelets is being vicariously performed by other cells in the body. This has also been shown experimentally by Bedson.[4] Splenectomy in a normal guinea-pig was followed by a great increase in the platelet-count, which was almost doubled in two days. In three or four weeks the count had fallen to normal. The spleen forms part of the reticulo-endothelial system, and Bedson[5] has shown experimentally that the system plays probably a part in the regulation of the number of platelets. The endothelial cells can be so packed with particulate matter, such as trypan blue, carbon, and colloidal silver, as temporarily to upset their functions. By 'blockading' the reticulo-endothelial system of normal rabbits in this way Bedson produced a transitory rise in platelets similar to that obtained after splenectomy. If splenectomy was performed on such an animal, there was no further increase of platelets. Blockade of the reticulo-endothelial system in a splenectomized animal in which the platelet-count had fallen to normal again, resulted in a rise in the count comparable to that obtained by 'blockading' the animal before removal of the spleen. He concludes from this that in the absence of the spleen the maintenance of the platelet balance is taken on by some other part of the reticulo-endothelial system.

Included in the reticulo-endothelial system are the endothelial cells of the bone-marrow, and the megakaryocytes, from which it is thought that platelets arise, are related to and derived from them (Woodcock[84]). The different results obtained by splenectomy in purpura hæmorrhagica may be explained by the conception that it is a disease of the reticulo-endothelial system, and that several types of the malady exist, depending on the part of the reticulo-endothelial system which is damaged—the megakaryocytes of the bone-marrow, the spleen, or the remainder of the system. It is suggested, though it cannot be proved, that the following three types may exist:—

Type I, in which the whole of the reticulo-endothelial system is uniformly affected. The diseased megakaryocytes produce defective platelets which are destroyed excessively by a diseased spleen and the remainder of the reticulo-endothelial system. Hence after splenectomy the result is poor; there is no cessation of hæmorrhages and the platelet-count after a preliminary rise continues to be diminished and the bleeding time prolonged. It is suggested that to this type belong cases Nos. 37, 44, 47, 78, 80, 84, and 97.

Type II, in which the spleen is mostly affected. In consequence an increased number of platelets is destroyed by the diseased spleen; in order

to keep up the numbers, the megakaryocytes are overworked and defective platelets are produced—a secondary myelopathy due to exhaustion. When the spleen is removed the marrow is enabled to recover and an increased number of normal platelets is produced. This type does well after splenectomy. The first case reported in this paper belongs to this group.

Type III, in which the bone-marrow and extrasplenic reticulo-endothelial system are damaged rather than the spleen; the platelets are reduced by the increased destructive activities of the extrasplenic reticulo-endothelial system. In this type splenectomy is useless: there is no rise in platelets after operation and no cessation of hæmorrhages. It is suggested that cases Nos. 13, 27, 30, and 81 are examples of this variety.

The two cases reported in this paper show by contrast the value of splenectomy as a therapeutic measure in this disease, and from an analysis of published results it appears that it is not often successful in the acute type of case; in the vast majority of the chronic, however, it has such beneficial effects as to warrant its performance as soon as the diagnosis of idiopathic purpura hæmorrhagica is made.

CONCLUSIONS.

1. The histological changes in the spleen in purpura hæmorrhagica are those of a general hyperplasia of the endothelial phagocytes.

2. The prolongation of the bleeding time is associated generally with diminution of the platelet-count, the coagulation time being normal.

3. The prolongation of the bleeding time in purpura hæmorrhagica is probably due more to defective quality of the platelets than to diminished numbers.

4. The transfusion of citrated blood in purpura hæmorrhagica is followed in some cases by a temporary fall in bleeding time to normal and a temporary rise in the platelet-count.

5. Purpura hæmorrhagica may be divided into acute and chronic cases; splenectomy is beneficial in 80·9 per cent of the chronic and in 16·6 per cent of the acute.

6. In most cases in which splenectomy is successful, there is a decrease in the bleeding time to normal and an increase in the platelet-count to normal or above normal. When the increase is above normal the count falls subsequently to normal. The normal number may be maintained, or there may be a gradual fall to thrombocytopenia. In some cases there is no rise in the platelet-count nor diminution of the bleeding time.

7. The immediate effect of splenectomy on the blood picture is an increase of erythrocytes and a leucocytosis with a normal proportion of cells. The leucocyte count falls gradually.

8. It is suggested that purpura hæmorrhagica is a disease of the whole of the reticulo-endothelial system, and that three types exist, depending on the extent of involvement of the system. The effect of splenectomy in a given case depends on the type to which the case belongs.

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APPENDIX.

ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY.

Author and History of Case	Dates and Operation	Blood Corpuscles: Red	Blood Corpuscles: White	Hb. %	Platelets	Bleeding Time	Remarks
Case No. 1. Bass and Cohen[2]		Thousands				Minutes	
F., age 8 .. .. 3 years—hæmorrhages from skin and nose	20. 7.23	5,200	4,800	60	11,000	20	Developed pneumonia after operation, which cleared up well. 5 months no recurrence of hæmorrhages. *Spleen:* weight, 180 grm. Slight hypertrophy of Malpighian bodies. Infiltration of pulp with polymorphs and eosinophils
	31. 7.23	4,500	?	60	2,000	16	
	31. 7.23 Splenectomy						
	1 hr. after splenectomy	4,500	21,600	60	42,000	5	
	1. 8.23	5,600	42,600	66	80,000	1	
	4. 8.23	4,800	16,800	56	220,000	1½	
	20. 8.23	?	9,600	75	100,000	1½	
	20.10.23	?	?	80	90,000	1½	
	10.12.23	?	?	85	60,000	1	
Case No. 2. Benecke[7]							
F., age 21 .. .. Hæmorrhages from nose, uterus, and skin. Duration 3 years	3. 7.17	2,150	3,200	30	66,000	?	5 years after operation, no recurrences of hæmorrhages. *Spleen:* weight, 250 grm. Hyperplasia of Malpighian bodies. Many platelets in evidence
	13. 7.17 Splenectomy			?			
	16. 7.17	3,250	11,000		344,000	?	
	30. 7.17	3,580	7,400	42	664,000	?	
	1. 9.17	4,176	4,900	52	577,000		
Case No. 3. Bowen[8]							
M., age 22 .. .. 18 years—purpura. 3 months—hæmorrhages from gums, nose, and anus	.. .. ..	1648–5000	4,800	18	2,500	20–120	4th week after operation: catarrhal jaundice. 9th week: slight epistaxis and purpura. 12th week: jaundice clearing. 4 months: no recurrence of hæmorrhages
	28. 8.22 Splenectomy						
	2 hrs. after splenectomy	..	..	..	17,000		
	4 hrs. ,, ..	..	..	..	22,000		
	29. 8.22	..	..	..	190,000	4	
	7. 9.22	..	..	..	608,000		
	28. 9.22	..	..	..	307,000		
	4. 9.22	..	..	..	100,000		
	11. 9.22	..	..	..	57,000	14	
	11.10.22	..	..	..	20,000	70	
	11.11.22	..	..	..	50,000	12	
	1. 1.23	..	..	..	95,000	8	
Case No. 4. Brill and Rosenthal[9]							
F., age 19 .. .. 14 years — hæmorrhages into skin and from nose, stomach, and uterus	Oct., 1922	2,272	6,800	38	6,400	+ +	Slight bleeding from gums after operation for short time. Vomited slight amount of blood once later. No recurrence 8 months after. *Spleen:* weight, 1400 grm. Vessels patent and not sclerotic. Numerous large follicles. Pulp present in normal amount. Sinuses not dilated or sclerosed. Myeloid metaplasia and hypertrophy of Malpighian bodies. No platelets
	2.12.22 Splenectomy						
	6 hrs. after splenectomy	4,350	56,000	70	95,000	?	
	3.12.22	4,144	40,000	66	225,000	1½	
	5.12.22	3,872	16,000	60	220,000	1	
	11.12.22	4,544	7,000	75	60,000	4	
	16.12.22	4,960	10,000	70	3,000	5	
	17. 1.23	5,632	16,000	80	6,000	?	
	13. 2.23	6,194	12,400	92	12,000	4½	
	24. 4.23	6,656	14,200	84	20,000		
Case No. 5. Brill and Rosenthal[9]							
M., age 15	May, 1919	3,960	23,000	70	80,000	7	Occasional slight epistaxes and petechiæ for short

Case No. 5. Brill and Rosenthal[9]							
M., age 15	May, 1919	3,960	23,000	70	80,000	7	Occasional slight epistaxes and petechiæ for short time after operation. No recurrence 5 months after. *Spleen:* weight, 300 grm. Malpighian bodies visible. Only hypertrophy. No platelets
3½ years—hæmorrhages from skin, gums, and nose	May, 1922	4,800	14,300	78	80,000	16	
	18.12.22	2,634	19,400	38	24,000	13	
	30.12.22	2,896	22,000	48	0	+ +	
	30.12.22 Splenectomy						
	2 hrs. after splenectomy	3,232	36,000	64	31,200	3	
	31.12.22	2,888	55,000	51	12,000	?	
	1. 1.23	2,992	30,400	46	10,000	5	
	5. 1.23	2,884	27,000	47	8,000	4	
	14. 2.23	4,704	12,000	80	12,000	3	
	6. 4.23	4,840	20,000	81	20,000	9	
	26. 5.23	5,120	50,000	83	50,000	10	
Case No. 6. Chauffard and Duval[12]							
F., age 16	Feb., 1925	3,540–2,220	7,500–11,200	37–70	60,000	28–36	Two days after operation, slight epistaxis with spontaneous arrest. 4 months after: no recurrence of hæmorrhages
11 years—hæmaturia and hæmorrhages from nose, ear, skin, gums, uterus, and conjunctiva	11. 3.25 Splenectomy						
	19. 3.25	..	..	..	1,800,000	?	
	20. 5.25	3,900	13,000	80	300,000	?	
Case No. 7. Clopton[13]							
M., age 5	26.12.23	..	..	..	?	13	Slight bleeding 6 months after. 9 months: no recurrence
Hæmorrhages into skin and nose	26.12.23 Transfusion						
	27.12.23	..	..	..	..	23	
	27.12.23 Transfusion						
	3. 1.23	..	..	..	..	33	
	14. 1.23 Transfusion						
	17. 1.23	3,600	12,000	?	Very few	13	
	19. 1.23	..	..	..	..	3	
	19. 1.23 Splenectomy						
	21. 1.23	..	59,000	..	..	Under 1	
	1. 3.23	..	95,000				
	1. 1.24	..	15,000	..	..	2	
Case No. 8. Clopton[13]							
F., age 5	Before splenectomy ..	2,500	11,000	?	Few	12–37	3 months: tonsillitis, petechiæ. 8 months: petechiæ. 11 months: tonsillitis and petechiæ. Health good, but three epistaxes. Result poor
Hæmorrhages into skin and nose	Few hrs. after splenectomy	?	53,000	?	Few	2	
	10 days after „ ..	..	..	..	50,000		
	3 mths. „ „ ..	..	..	..	50,000	14	
	8 mths. „ „ ..	..	..	..	20,000	2	
	10 mths. „ „ ..	..	..	..	200,000	16–20	
	11 mths. „ „ ..	..	..	..	90,000	3½	
	14 mths. „ „ ..	..	..	..	120,000	2	

Continued on next page

ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY—*continued.*

AUTHOR AND HISTORY OF CASE	DATES AND OPERATION	BLOOD CORPUSCLES		Hb. %	PLATELETS	BLEEDING TIME	REMARKS
		Red	White				
Case No. 9. Clopton[13]		Thousands				Minutes	
F., age 34	.. .. ..	2,700	3,500	40	70,000	4–8	Worse after transfusion: hæmorrhages from gums and nose. 6 months after: no recurrence of hæmorrhages
4 months — hæmorrhages into skin and nose	Transfusion ..						
	2 days after splenectomy	4,500	20,000	45	250,000	3½	
	6 months „ ..	4,060	19,600	49	180,000	2	
Case No. 10. Cohn and Lemann[14]							
M., age 5½	3. 6.23	3,780	6,500	55	Very few	5	Developed pneumonia during convalescence. Recovered well. 6 months: no recurrence of hæmorrhages
3 months — hæmorrhages into skin ..	6. 6.23 Splenectomy						
	2. 7.23	4,730	8,700		400,000	?	
	15.10.23	..	..	..	200,000	?	
Case No. 11. Cori[15]							
F., age 13	.. .. ..	2,000	8,800	?	Very few	6	No recurrence of hæmorrhages after 10 months
4 years—hæmorrhages into skin and nose	24. 2.21 Splenectomy						
	5 hrs. after splenectomy	..	..	..	109,000	3	
	27. 2.21	..	..	..	386,000		
	4. 3.21	..	..	..	740,000		
	1. 6.21	..	..	..	271,000		
	1.11.21	..	..	..	145,000		
	1. 2.22	..	..	..	23,000		
Case No. 12. Cori[15]							
F., age 21	Before splenectomy ..	4,200	?	40	Very few	?	Malarial parasites found in blood and patient died from subphrenic abscess 1 month after operation. *Spleen:* weight, 320 grm. Contained many platelets
9 years—hæmorrhages from nose, gums, and uterus	17.11.21 Splenectomy						
	8 hrs. after splenectomy	..	..	..	63,000	?	
	18.11.21	..	..	..	307,000	?	
	21.11.21	..	..	..	862,000	?	
	5.12.21	..	..	..	1,150,000	?	
	6.12.21	..	..	..	89,500	?	
Case No. 13. Corpus[16]							
M., age 56	4. 5.25	?	?	?	0	?	Death following heart failure. Autopsy: degeneration of myocardium; hæmorrhages into endocardium, peritoneum, and stomach
2 months — hæmorrhages	9. 5.25 Splenectomy						
	9. 5.25	..	..	..	0		
Case No. 14. Cowen[17]							
F., age 27	4. 2.25	4,040	11,000	70	10,000	21	3 hours after operation: hæmorrhage from gums stopped. 4 days: vaginal hæmorrhage stopped. 4 months: no recurrence. *Spleen:* weight, 120 grm. Endothelial activity throughout. Germinal centres of Malpighian bodies large and prominent. Proliferation of endothelial cells lining sinuses well marked. Fewer lymphocytes
8 months—malaise. 10 days — hæmorrhages from nose, vagina, gums, skin	10. 2.25 Splenectomy						
	15. 2.25	..	..	..	Very few	4	
	24. 2.25	..	..	..	600,000	3	
	7. 3.25	..	..	..	1,000,000	3	
	13. 3.25	..	..	..	200,000	3	than normal. Interior of capillaries and smaller arteries hypertrophied. No increase of fibrous tissue
	21. 3.25	..	..	..	400,000	3	
	17. 4.25	5,400	..	85	550,000	?	

gums, skin	7. 3.25	..	..	..	1,000,000	3	lining sinuses well marked. Fewer lymphocytes
	13. 3.25	..	..	..	200,000	3	than normal. Interior of capillaries and smaller
	21. 3.25	..	..	..	400,000	3	arteries hypertrophied. No increase of fibrous
	17. 4.25	5,400	..	85	550,000	?	tissue
Case No. 15. Ehrenberg[21]							
F., age 19	Before splenectomy ..	?	?	?	0	20–120	4½ years after operation: no recurrence of
4 years—hæmorrhages	2½ hours after splenec-						hæmorrhages
from nose, skin, and	tomy	..	..	..	87,500		
uterus	1 day after splenectomy	..	..	..	118,000		
	5 days ,, ..	..	..	..	684,000	3–6	
	2 months ,, ..	..	..	..	60,000		
	4½ years ,, ..	..	..	..	19,000		
Case No. 16. Engel[22]							
F., age 22	.. .. ..	2,120	?	35	19,000	?	1st day after operation: menorrhagia and
9 years—hæmorrhages	3rd day after splenec-						curettage. 2nd day: transfusion. 2½ months:
from skin, gums, and	tomy	..	..	50	230,000	?	no recurrence after 2nd day
uterus	10 weeks after splenec-						
	tomy	..	..	93	148,000		
Case No. 17. Engel[22]							
M., age 29	Before splenectomy ..	4,500	?	76	0	180	Patient died 4 hours after operation. Autopsy:
3 days—hæmorrhages							hæmorrhages into skin and serous cavities;
from skin, gums, kid-							necrosis of bone
ney, stomach, and bowel							
Case No. 18. Engel[22]							
M., age 44	Before splenectomy ..	2,210	?	44	90,000	?	Died 6 hours after operation. Autopsy: hæmor-
3 days—hæmorrhages							rhages into gastro-intestinal tract, genito-
from skin, kidney, and							urinary tract, and heart. Tuberculosis of
bowel							lymph gland
Case No. 19. Engel[22]							
F., age 17	.. .. ..	1,240	?	20	14,800	12	Severe nose-bleed on 12th day. No recurrence
10 days—hæmorrhages	1 day after splenec-						after 3 months
from skin, gums, and	tomy ..	..	..	..	29,000		
uterus	2 days ,, ..	..	..	..	115,000		
	12 days ,, ..	..	..	..	101,000		
	3 months ,, ..	4,600		70	176,000		
Case No. 20. Eylenberg[23]							
F., ? age	Before splenectomy ..	1,252	?	25	38,420	?	3 months after operation: no recurrence
Hæmorrhages into skin,	3 days after splenectomy	..	..	..	34,400		
and from uterus	2 months ,, ..	..	..	..	577,000		

Continued on next page

ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY—*continued*.

AUTHOR AND HISTORY OF CASE	DATES AND OPERATION	BLOOD CORPUSCLES		Hb. %	PLATELETS	BLEEDING TIME	REMARKS
		Red	White				
Case No. 21. Farley[24]		Thousands				Minutes	
F., age 18	4.11.24	3,000	9,600	35	?	?	Differential W.B.C.:—
2 months — hæmorrhages into skin and from gums and vagina	11.11.24	945	9,400	25	40,000	20	4.11.24 per cent / 18.11.24 per cent / 23.11.24 per cent Polymorphs .. 31 / 50 / 42 Lymphocytes .. 32 / 7 / 3 Large mononuclears 2 / 1 / — Transitionals .. 4 / 2 / — Eosinophils .. — / — / — Myelocytes .. 31 / 40 / 55
	12.11.24 Transfusion						
	15.11.24 Transfusion Splenectomy						
	16.11.24	1,270		25	80,000		
	18.11.24	1,043	37,000	25	70,000		
	19.11.24 Transfusion..	786	54,000	20	64,000		
	22.11.24 Transfusion..	..	23,000	..	39,000		*Spleen :* blood spaces filled with myeloblasts and myelocytes. No uniform hyperplasia of cells *in situ* with destruction of architecture so characteristic of the myeloid hyperplasia of myeloid leukæmia. ? Purpura hæmorrhagica. ? Acute myeloid leukæmia
	23.11.24	..	55,000	..	105,000		
	28.11.24	1,100	53,000	20	7,200		29.11.24 : died
Case No. 22. Giffin[28]							
F., age 31	Dec., 1922	3,260	?	55	24,000	++	3–4 days after operation: slight oozing from uterus. 20 months after: no recurrence. *Spleen :* weight, 210 grm. Increase in number of neutrophils in splenic pulp. Germ centres apparently active. Some brown pigment. Otherwise normal
1½ years—hæmorrhages into skin and from nose, gums, and uterus	Jan., 1923	1,610	7,000	18	?	?	
	Just before splenectomy	..	..	..	40,000	?	
	7. 3.23 Splenectomy						
	6 hrs. after splenectomy	..	..	..	202,000		
	9. 3.23	..	..	..	727,000		
	23. 3.23	..	..	..	365,000		
	21. 4.23	4,000	..	68	..		
Case No. 23. Giffin[28]							
F., age 23	June, 1923	3,370	7,200	54	116,000	22	No recurrence until 1 year later when vaccinated, arm sore but no secondary infection: crop of petechiæ. 17 months after operation: no recurrence. *Spleen :* weight, 200 grm. Nothing abnormal except increase in number of neutrophils, and several eosinophilic myelocytes. Small amount of brownish pigment in pulp. Germ centres apparently active
13 years—hæmorrhages from skin, nose, and uterus	Aug., 1923	..	..	..	28–76,000		
	Sept., 1923	..	..	..	136,000	18	
	27.10.23	4,430	8,800	55	62,000	6½	
	29.10.23 Splenectomy						
	5 hrs. after splenectomy	..	..	..	86,000		
	30.10.23	..	..	..	146,000	2½	
	4.11.23	..	..	..	638,000		
	13.11.23	4,990	12,700	58	214,000	4	
	5½ mths. after operation	..	10,000	..	150,000	1½	
Case No. 24. Giffin[28]							
M., age 24	Jan., 1920	3,770	5,000	23	88,000	40	Wassermann reaction positive, but no clinical evidence of syphilis. 10 months after operation: no recurrence. *Spleen :* weight, 220 grm. Normal except for increase in number of neutrophils. Many eosinophils
12 years—hæmorrhages from nose, gums, and skin	July, 1921	4,860	5,100	66	284,000	33	
	Feb., 1924	..	..	..	182,000	20	
	22. 2.24 Splenectomy						
	2 wks. after splenectomy	..	..	..	260,000	2	
Case No. 25. Giffin[28]							
F., age 11	Mar., 1924	3,480	9,800	56	46,000	38	2nd day after operation: epistaxis. 3 weeks after: coryza, petechiæ, and epistaxis. 1 year

Case No. 25. Giffin[28]							
F., age 11 .. .. 5½ years—hæmorrhages from nose and skin	Mar., 1924	3,480	9,800	56	46,000	38	2nd day after operation: epistaxis. 3 weeks after: coryza, petechiæ, and epistaxis. 1 year after: no recurrence of hæmorrhage. *Spleen:* weight, 168 grm. Normal except that blood-vessels in the Malpighian bodies were hyalinized. Some pigment, but no more than normal. Perhaps an increase in number of neutrophils
	19. 3.24 Splenectomy						
	20. 3.24	..	..	..	100,000	8	
	22. 3.24	..	..	..	98,000	5	
	24. 3.24	..	..	..	430,000		
	25. 3.24	..	..	..	208,000	2½	
	3 wks. after splenectomy	..	..	..	50,000		
Case No. 26. Halban[30]							
F., age 17 .. .. 18 months—hæmorrhages from nose and uterus	Before splenectomy ..	3,000	?	40	Very few	17	6 months after operation: no recurrence of hæmorrhages
	3 mths. after „ ..	4,500	..	..	170,000		
Case No. 27. Harttung[31]							
M., age 45 .. .. 1 month—hæmorrhages into skin and from nose and gums	13. 8.24	3,150	7,300	70			3 days after operation: collapse. 7 days after: died
	4. 9.24	1,630	8,300	30	100,000	15	
	5. 9.24 Transfusion						
	9. 9.24	3,300	..	30			
	23. 9.24	960	..	20	70,000		
	23. 9.24 Transfusion						
	24. 9.24 Splenectomy Transfusion						
	1.10.24	1,900	..	..	160,000		
Case No. 28. Hauke[32]							
F., age 5 .. .. 3 years—hæmorrhages from nose and stomach	Before splenectomy ..	1,300	?	15	800	36	6 months after operation: only occasional petechiæ
	2½ mths. after „ ..	6,700	..	62	19,000	?	
	6 mths. after „ ..	4,160	..	81	3,600		
Case No. 29. Henrahan[33]							
F., age 46 .. .. 6 months — hæmorrhages from skin, uterus, and bowel	Before splenectomy ..	4,200	..	?	Few	6	Died 2 hours after splenectomy. No autopsy
Case No. 30. Henrahan[33]							
F., age 21 .. .. 18 months — hæmorrhages from gums, uterus, and skin	Before splenectomy ..	1,600	?	32	120,000	17	30 days after operation: died. Autopsy: furunculosis, abscesses in lungs, myocardium, and kidneys
	1 day after splenectomy	..	..	..	120,000	?	
	18 days after „	..	..	..	160,000	?	
Case No. 31. Herfarth[34]							
M., age 19 .. .. 7 years—hæmorrhages into skin and from nose	Before splenectomy ..	3,100	?	35	30,000	23	No recurrence of hæmorrhages
	1 day after „ ..	..	..	..	30,000		
	Later	..	..	..	350,000		

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ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY—*continued.*

AUTHOR AND HISTORY OF CASE	DATES AND OPERATION	BLOOD CORPUSCLES		Hb. %	PLATELETS	BLEEDING TIME	REMARKS
		Red	White				
Case No. 32. Herfarth[34]		Thousands				Minutes	
F., age 23	Before splenectomy ..	3,700	?	61	30,000	?	3 months after operation: no recurrence
3 years—hæmorrhages	10 days after „ ..	..	..	..	180,000	?	
from nose and uterus	3 months after „ ..	4,400	..	58	344,000	2	
Case No. 33, Herrman[36]							
F., age 16	Before splenectomy ..	2,500	?	60	?	?	Died a few hours after splenectomy. Autopsy: subcutaneous, subserous, and parenchymatous hæmorrnages
4 days — hæmorrhages from nose, skin, and uterus							
Case No. 34. Hitzrot[37]							
F., age 8	27. 1.23	2,400	38,000	40	40,500	20	27.1.23; leucocytosis owing to bronchopneumonia. No recurrence 2 months after. *Spleen:* weight, 120 grm. Hyperplasia of pulp. Myeloidization. Many follicles of normal size. Many polymorphs. Arteries in follicles show thickening and hyaline degeneration of wall. Moderate number of myelocytes. Slight increase of eosinophils. No platelets
3 years—hæmorrhages	27. 2.23 Splenectomy						
from nose, skin, gums,	"After operation" ..	..	..	..	600,000	5	
stomach; melæna	26. 4.23	..	..	40	++	2½	
Case No. 35. Kaznelson[38]							
F., age 36	1.10.16	3,100	2,760	?	300	?	No recurrence of hæmorrhages 10 years after
Since childhood—petechiæ and purpura. 10	10.10.16 Splenectomy						
years — purpura and	12.10.16	..	..	..	600,000	Normal	
menstruation 10 days	18.10.16	..	..	..	460,000		
	1.11.16	..	..	..	231,000		
	16.11.16	..	..	..	183,000		
	28.11.16	..	..	..	90,000		
	18.12.16	..	..	..	125,000		
	23. 3.17	..	..	..	124,000		
	31. 7.17	..	..	..	164,000		
	30. 9.24	..	..	..	332,000		
Case No. 36. Kaznelson[39]							
F., age 25	14.11.16 ..	5,000	?	?	500	?	5 months after: occasional slight epistaxis. No recurrence after 5 years
5 years—hæmorrhages	18.11.16 Splenectomy						
into skin and from	2 hours after „	..	..	..	8,800		
nose and uterus	19.11.16	..	..	..	93,000		
	21.11.16	..	..	..	246,000		
	27.11.16	..	..	..	17,800		
	9.12.16	..	..	..	3,000		
	21.12.16	..	..	..	8,500		
	19. 2.17	..	..	..	33,400		
	30. 7.17	..	..	..	10,100		
	30. 4.25	..	..	..	Normal		
Case No. 37. Kaznelson[40]							
F., age 11	Before splenectomy ..	5,500	?	120	6,700	?	25.12.16: severe epistaxis and hæmatemesis

Case No. 37. Kaznelson[40]							
F., age 11 .. .. 3 years—petechiæ, epistaxis	Before splenectomy ..	5,500	?	120	6,700	?	25.12.16: severe epistaxis and hæmatemesis. 1925: a few petechiæ and occasional epistaxis
	18.12.16 Splenectomy						
	3½ hours after „	..	..	..	13,100		
	19.12.16	..	..	..	216,000		
	23.12.16	..	..	..	58,000		
	25.12.16	..	..	..	13,000		
	12. 1.17	..	..	..	1,700		
	17. 5.17	..	..	..	5,500		
	13. 9.17	..	..	..	6,800		
	1925	..	..	..	1,000		
Case No. 38. Kaznelson[41]							
F., age 20 .. .. 1 month — hæmorrhage from nose, uterus, and under skin	11.11.20	..	..	..	600		11.11.20: died at operation. Autopsy: marked degeneration and bleeding into myocardium
	11.11.20 Splenectomy						
Case No. 39. Kaznelson[41]							
F., age 30 .. .. Several years—hæmorrhage from nose, uterus, and under skin	20. 6.21	..	..	..	42,000		No recurrence after 4 years
	20. 6.21 Splenectomy						
	21. 6.21	..	..	..	385,000		
	23. 6.21	..	..	..	530,000		
	26. 7.21	..	..	..	963,000		
	1. 8.21	..	..	..	1,370,000		
	10. 2.22	..	..	..	280,000		
	1. 7.25	..	..	..	200,000		
Case No. 40. Keismann[42]							
F., age 17 .. .. 4 years—hæmorrhages from gums and stomach	Before splenectomy ..	2,400	?	40	4,500	?	6 months after: occasional epistaxis. 1 year after: severe menorrhagia. Result poor
	6 hours after splenectomy	..	..	..	220,000	?	
	6 months after splenectomy	4,000	..	75	240,000	?	
Case No. 41. Von Krehl[44]							
F., age 26 .. .. Hæmorrhage from nose and uterus	Jan., 1925	..	..	..	10,000	37	6.10.25: No recurrence
	Feb., 1925	..	..	..	900	50	
	17. 2.25 Splenectomy						
	18. 2.25	..	..	..	20,000	½	
	25. 2.25	..	..	..	60,000		
	28. 2.25	..	..	..	100,000		
	6.10.25	..	..	..	138,000		

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ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY—*continued.*

AUTHOR AND HISTORY OF CASE	DATES AND OPERATION	BLOOD CORPUSCLES		Hb. %	PLATELETS	BLEEDING TIME	REMARKS
		Red	White				
Case No. 42. Lafourcade[45]		Thousands				Minutes	
F., age 9	24. 3.26	2,410	4,000	30	Very few		March and April: no hæmorrhage. May: 4 epistaxes. May: X-rays again, followed by hæmorrhage. 27.8.26: Transfusion followed by considerable purpura. 15 days after operation: all purpura disappeared. 17 days after: thrombosis left femoral vein. 3 months after: no recurrence. *Spleen:* weight, 240 grm. Hypertrophy of pulp, especially of Malpighian bodies. Hypertrophy and hyperplasia of macrophages of pulp
2 years—hæmorrhage from nose, skin, kidney, stomach: melæna	Mar. & April, X rays to spleen ..						
	6. 5.26	3,850	3,600	70	++		
	27. 8.26	2,000	6,000	20	12,000	8	
	28. 8.26 Splenectomy						
	18.11.26	3,500	10,000	70	200,000	Normal	
Case No. 43. Larrabee[46]							No recurrence 4 months after splenectomy. No details
Case No. 44. Lee[48]							
F., ? age	Before splenectomy ..	..	..	..	20,000	30	Continued to bleed from uterus. Died 2 weeks after operation. Autopsy: negative
Chronic hæmorrhages under skin and from uterus	1 day after ,, ..	..	..	..	80,000		
	7 days after ,, ..	..	..	..	200,000		
Case No. 45. Lesche[49]							
M., age 42	July, 1925	..	..	..	0	30+	Death after operation from heart failure
Bleeding from gums..	July, 1925 Splenectomy						
Case No. 46. Lesche and Wittkower[49]							
F., age 32	19. 5.21	..	..	..	85,000	11½	No recurrence
Hæmorrhage from nose, uterus, and skin	19. 5.21 Splenectomy						
	20. 5.21	..	..	..	153,000		
	21. 5.21	..	..	..	178,000		
	24. 5.21	..	..	..	261,000		
	26. 5.21	..	..	..	363,000		
Case No. 47. Lesche and Wittkower[49]							
F., age 53	2.12.21	..	..	..	27,000	72	10.12.21: died
Hæmorrhages into skin, brain, and mucous membrane of mouth	3.12.21 Splenectomy						
	4.12.21	..	..	..	530,000	1½	
	9.12.21	..	..	..	0		
Case No. 48. Mayo Clinic[50]							
M., age 32	Before splenectomy ..	..	..	..	36,000	15	5 months after operation: no recurrence
2 years—hæmorrhages into skin and sclerotics and from gums, nose, kidney, bowel. Arthritic pains	8.10.24 Splenectomy						
	14.10.24	..	..	..	684,000	5	
	19.10.24	..	..	..	816,000	2½	
Case No. 49. Mayo Clinic[50]							
					54,000	10	5 months after operation: no recurrence

Case No. 49. Mayo Clinic[50]							
F., age 11	Before splenectomy ..	..	..	..	54,000	10	5 months after operation: no recurrence
5½ years—hæmorrhages	10.10.24 Splenectomy						
into skin and sclerotics	13.10.24	..	..	..	643,000	3½	
and from gums, vagina,	16.10.24	..	..	..	780,000		
and bowel	28.10.24	..	..	..	88,000	2½	
Case No. 50. Mayo Clinic[50]							
F., age 15	Before splenectomy ..	1,370		14	42,000	6	5 months after operation: no recurrence
10 years—hæmorrhages	16.10.24 Splenectomy						
into skin and from	19.10.24	..	..	..	64,000		
nose and uterus	21.10.24	..	..	..	516,000	7½	
	31.10.24	..	..	..	408,000	6½	
Case No. 51. Mayo Clinic[50]							
F., age 22	Before splenectomy ..	1,800		15	42,000	++	5 months after operation: no recurrence
9 years—hæmorrhages	23.10.24 Splenectomy						
from uterus, nose,	4 hours after „	..	..	..	200,000		
gums, and skin	1.11.24	..	..	..	840,000		
Case No. 52. Mayo Clinic[50]							
M., age 27	Before splenectomy ..	4480–2990	13,200	73–45	52–134000	3–20	Differential W.B.C. normal. 3 months after operation: well. No recurrence
29 months—hæmor-	12. 1.25 Splenectomy						
rhage from nose, gums,	20. 1.25	..	..	..	360,000	Normal	
conjunctivæ, and into	25. 1.25	..	..	..	504,000		
skin	2. 2.25	3,840	10,600	67	308,000		
Case No. 53. Mayo, J.[51]							
F., age 9	Before splenectomy ..	2,500	?	30	180,000	?	Much bleeding during operation: transfusion on table. Bleeding from incision for 4 days: 3 transfusions. Blood platelets not increased and bleeding time not diminished while in hospital. Some months later: well, no recurrence
8 years—hæmorrhages	3. 8.27 Splenectomy						
from skin and nose							
Case No. 54. Meyerstein[52]							
F., age 12	15. 3.21	4,500	9,700	60	3,000	25	Died: accident at operation
4 years—purpura, epis-	28. 3.21	..	..	..	24,000		
taxis, and hæmaturia	17.10.21	..	..	..	90,000	20	
	8. 1.23	..	..	..	24,000	11	
	15. 2.23	1,900	..	20	27,000	25	
	25. 2.23 Splenectomy						
Case No. 55. Minkowski[53]							
M., age 53	Before splenectomy ..	5,200	5,400	56	14–29,000	19	28.10.19: epistaxis. 2½ years: no recurrence. *Spleen:* not large. No striking changes. Many platelets
Several years—purpura.	7.10.19 Splenectomy						
2½ years—epistaxis	7 hours after „	..	..	..	56,000		
	9.10.19	..	..	..	100,000		
	30.10.19	..	..	..	60,000	15	
	7.12.19	..	..	..	31,000	7	
	2½ years after splenec-						
	tomy	..	..	..	365,000		

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ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY—*continued.*

AUTHOR AND HISTORY OF CASE	DATES AND OPERATION	BLOOD CORPUSCLES		Hb. %	PLATELETS	BLEEDING TIME	REMARKS
		Red	White				
Case No. 53. Mino[54]		Thousands				Minutes	
F., age ? .. .. 10 years — hæmorrhages into skin and mucous membranes	Before splenectomy ..	..	..	..	10,000		2 years after operation; well. No recurrence
	43 hrs. after ,, ..	..	..	..	300,000		
	2 yrs. after ,, ..	..	..	..	155,000		
Case No. 57. Moschowitz[55]							
No details							Blood platelets doubled after operation. No recurrence
Case No. 58. Myers[56]							
F., age 10 .. .. 16 months — hæmorrhages from mouth, nose, and gums	Before splenectomy ..	4,980	4,800	42	Almost 0	20	*Before operation:* polymorphs, 30 per cent; large lymphocytes, 45 per cent; small lymphocytes, 15 per cent; large mononuclears, 2 per cent; eosinophils, 1 per cent; mast cells, 2 per cent; leucoblasts, 3 per cent; plasma cells, 2 per cent. *After operation:* slight fall in R.B.C., then a rise after a short time to 6½ million. W.B.C. after operation 26,000, gradually falling to 12,600; at first lymphocytes very few, then rising to normal. No recurrence of hæmorrhages
	13.11.25 Splenectomy						
	14.11.25	..	..	..	50,000	Normal	
	1.12.25	..	..	..	390,720		
	13.4.26	..	..	..	479,200	<2	*Spleen:* Proliferation of endothelium of pulp sinuses. Lymphocytes of pulp greatly diminished, their places being taken by active endothelial cells, many of which contained fragments of cells which may have been phagocytosed platelets. No free iron, so that hæmolysis of red cells not excessive
Case No. 59. Myers, Maingot, and Gordon[57]							
F., age 29 .. .. 17 years — hæmorrhages into skin and from nose and mouth. Uterine hæmorrhages for 4 weeks after childbirth	13. 1.26	6,504	9,000	60	60,000	15	13.1.26 per cent; *Just after incision* per cent; *During sewing up* per cent Polymorphs 65; 75; 80 Large lymphocytes 15; 10; 8 Small lymphocytes 15; 10; 8 Hyaline .. 3; 3; 2 Eosinophils 2; 2; 2
	15. 1.26 Splenectomy						
	Just after incision ..	6,680	17,200	..	33,000		
	During sewing up ..	6,220	25,400	..	124,000		
	17. 1.26	4,920	27,000	70	197,000		17.1.26; 21.1.26 Polymorphs.. .. 60 per cent; 70 per cent Large lymphocytes 10 ,, ,,; 10 ,, ,, Small lymphocytes 15 ,, ,,; 15 ,, ,, Hyaline .. .. 4 ,, ,,; 3 ,, ,, Eosinophils .. 1 ,, ,,; 2 ,, ,, Myelocytes .. 6 ,, ,,; — Metamyelocytes .. 4 ,, ,,; —
	21. 1.26	6,372	9,200	76	318,000		No recurrence of hæmorrhages *Spleen:* Malpighian bodies normal. Sinuses of pulp showed excessive proliferation of endothelial cells, many being in mitosis. No excess of fibrous tissue
Case No. 60. Myers, Maingot, and Gordon[57]							
M., age 6	23. 1.26	3,256	5,600	55	0	?	23.1.26 Polymorphs.. .. .. .. 45 per cent Large lymphocytes .. .. .. 20 ,, ,,

Case No. 60. Myers, Maingot, and Gordon[57]							
M., age 6 .. .. 1 month — hæmorrhages from gums, bowel, mouth, and skin	23. 1.26	3,256	5,600	55	0	?	23.1.26 Polymorphs .. .. 45 per cent Large lymphocytes .. .. 20 ,, ,, Small lymphocytes .. .. 25 ,, ,, Hyaline .. .. 2 ,, ,, Eosinophils .. .. .. 1 ,, ,, Türk cells .. .. 4 ,, ,, Myelocytes .. .. 2 ,, ,, *Before Operation* per cent / *After Operation* per cent / 9.2.26 per cent Polymorphs .. 20 / 20 / 20 Large lymphocytes 30 / 30 / 25 Small lymphocytes 35 / 35 / 45 Hyaline .. 5 / 5 / 3 Eosinophils .. 1 / 1 / 0 Plasma cells .. 9 / 9 / 0 Myelocytes .. 0 / 0 / 4 Leucoblasts .. 0 / 0 / 3 March 12, 1926: no recurrence. *Spleen:* Splenic pulp an irregular mass of proliferating cells distending the sinuses; these are endothelial cells derived from lining of pulp sinuses. Very few R.B.C. Lymphocytes diminished
	5. 2.26						
	During anæsthesia	5,584	37,600	55	0	?	
	Splenectomy ..						
	After operation ..	5,180	37,800	55	104,000	?	
	9. 2.26	2,550	5,400	40	204,000		
	13. 2.26	4,970	11,600	40	250,000	5	
Case No. 61. Naegeli[58]							
M., age 24 .. .. Hæmorrhages from nose and gums and into skin	5. 1.22	..	..	..	5,400		Hæmorrhages cleared up slowly
	24. 5.22 Splenectomy						
	End of May ..	..	..	..	1,600,000		
	Later	..	..	..	500,000		
Case No. 62. Peterson[60]							
M., age 6 .. .. Chronic hæmorrhages from nose and into skin	Before splenectomy ..	..	..	..	16,000	++	Developed a hemiplegia 10th day after splenectomy and died 13th day
Case No. 63. Retzlaff[61]							
Splenectomy successful. No details							
Case No. 64. Ricaldoni and Albo[62]							
F., age 18 .. .. 3½ years — menorrhagia and hæmorrhage from nose and gums and into skin. May, 1922, severe anæmia and great prostration. Transfusion led to slight improvement, periods regular but long	18. 5.22	3,500	5,400	20	Very few	?	18.5.22 / 25.10.22 / 7.11.22 Polymorphs .. .. 65 per cent / 88 per cent / 62 per cent Eosinophils .. .. 1 / — / 2 Small mononuclears .. 33 / 10 / 32 Large mononuclears .. 1 / 2 / 4 2 years after operation: leading normal life. No recurrence. *Spleen:* weight, 345 grm. Slight thickening of capsule. Congested. Vessels dilated and full of blood. Endothelial cells of sinuses swollen. Increased amount of fibrous tissue and lymphoid cells of different sizes. Lymphatic follicles large and numerous: no visible karyokinesis *Continued on next page*
	23.10.22 Splenectomy						
	25.10.22	4,500	31,000	70	359,000		
	7.11.22	4,100	10,500	55	..		

ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY—*continued.*

AUTHOR AND HISTORY OF CASE	DATES AND OPERATION	BLOOD CORPUSCLES		Hb. %	PLATELETS	BLEEDING TIME	REMARKS
		Red	White				
Case No. 65. Ricaldoni and Albo[62]		Thousands				Minutes	6.4.23 per cent / 21.11.23 per cent / 17.12.23 per cent
F., age 25	6. 4.23	2,500	14,000	30	Very few	5½	Polymorphs .. .. 86 / 62 / 66
Since infancy — repeated epistaxis, petechiæ, and ecchymoses. Jan., 1923 — hæmorrhage from uterus and gums	21.11.23	4,940	9,000	78	70,000	?	Basophils .. .. 1 / — / —
	12.12.23 Splenectomy						Small menonuclears .. 11 / 30 / 28
	17.12.23	4,750	16,000	75	170,000		Large mononuclears .. 1 / 6 / 4
	27.12.23	..	..	..	..	½	Myelocytes .. .. 1 / — / —
							Eosinophils .. .. — / 2 / 2
							Next period after operation normal. No follow-up. *Spleen:* Weight, 81 grm. Considerable hyperplasia and hypertrophy of lymphoid follicles, in which karyokinesis seen. Pulp contained many cells—lymphoid, mononuclears, polymorphs, eosinophils, and a few megakaryocytes. Increase of endothelials
Case No. 66. Rixford[63]							
F., age 40	Before splenectomy ..	2,180	?	43	Almost 0	++	Normal menses followed operation. Two months after operation she developed acute myeloid leukæmia and died 4 months after operation
Chronic hæmorrhages from uterus, skin, gums, and nose	19 days after operation	..	..	..	100,000		
	32 days after operation	3,300	..	42	167,000		
Cases Nos. 67–72. Rosenthal[65]							
Classified as chronic purpura hæmorrhagica. Results following splenectomy at intervals not stated were all good							
Cases Nos. 73, 74. Rosenthal[65]							
Acute cases. Both died shortly after operation							
Case No. 75. Schilling[67]							
F., age 26	12. 2.25	..	..	..	Very few	++	20.3.25: free from hæmorrhages
Hæmorrhages into skin and gums	18. 2.25 Splenectomy						
	18. 2.25	..	..	..	2,100		
	26. 2.25	..	..	..	455,000		
	7. 3.25	..	..	..	696,000		
Case No. 76. Schmidt[68]							
Chronic hæmorrhages into skin. ? age and sex	Before splenectomy ..	?	?	?	Very few	?	No recurrence
	After splenectomy ..	?	?	?	Increased	?	
Case No. 77. Schmidt[68]							
M., age 11	Before splenectomy ..	?	?	?	Very few	?	Epistaxis improved, and petechiæ fewer
Chronic epistaxis and hæmorrhage into mucous membrane and skin	After splenectomy ..	?	?	?	Increased	?	
Case No. 78. Singleton[69]							
F., age 49	Before splenectomy ..	2,900	?	50	Very few	15	8 months after operation re-admitted with bleeding from gums. 10 months after operation died of massive hæmorrhages into right ventricle of
6 months — hæmor-	10 days af. splenectomy	..	..	..	180,000		

Case No. 78. Singleton[69]

F., age 49 .. .. 6 months — hæmorrhages into skin and gums	Before splenectomy ..	2,900	?	50	Very few	15	8 months after operation re-admitted with bleeding from gums. 10 months after operation died of massive hæmorrhages into right ventricle of brain: also bleeding from vagina, skin, and gums
	10 days af. splenectomy	..	..	..	180,000		
	22 „ „ ..	..	..	..	0		
	30 „ „ ..	..	..	..	200,000		
	4 mths. „ ..	..	..	..	16,000		
	9 „ „ ..	..	..	..	24,000		

Case No. 79. Spence—Professor Fraser's case

F., age 6 .. .. 1 year—hæmorrhages from nose and gums, into skin and mucous membrane of mouth and once from bowel, and urinary tract	7. 8.26	5,170	5,200	70	6,450	>30	
	21. 9.26	3,900	7,200	68			
	6.10.26 Transfusion						
	7.10.26 Tonsillectomy						
	14.10.26						
	17.11.26	4,150	9,600	55	20,750	11½	
	24.11.26 Transfusion	(Before transfusion)				5¾	
	25.11.26 Tonsillectomy	4,630	8,600	..	138,900	2½	
	26.11.26	..	..	..	173,200	1½	
	28.11.26	..	..	..	123,700	14	
	4.12.26	..	..	..	154,300	14½	
	24. 1.27	4,580	6,200	61·8	45,800	15½	
	31. 1.27 Transfusion						
	1. 2.27 Splenectomy	..	..	..	115,200	1¼	
	3. 2.27	4,480	7,200	..	203,600	2 7/60	
	7. 2.27	..	..	..	344,600	¾	
	17. 2.27	5,940	10,000	..	283,000	⅔	
	10. 6.27	4,860	31,400	..	243,000	1 7/60	
	23. 9.27	4,810	14,000	..	400,000	¾	

	7.8.26	17.11.26	3.2.27
Polymorphs ..	3,900	6,672	3,888
Lymphocytes ..	1,090	1,968	2,016
Large mononuclears	155	672	1,080
Eosinophils ..	55	288	36
Basophils ..	—	—	36
Myelocytes ..	—	—	36
Abnormal lymphocytes	—	—	108

	17.2.27	10.6.27	23.9.27
Polymorphs ..	5,750	22,137	7,280
Lymphocytes ..	2,600	5,338	4,830
Large mononuclears	700	3,140	770
Eosinophils ..	450	785	770
Transitionals ..	450	—	210
Myelocytes ..	50	—	—
Basophils ..	—	—	140

8 months after operation: no recurrence of hæmorrhages. *Spleen:* weight, 117 grm. Lymphoid nodules exaggerated, and contained large germinal centres of endothelial cells. Increase of endothelial reticulum throughout, with diminution of lymphoid cells.

Case No. 80. Spence—Dr. Graham's case

M., age 23 .. .. 6 months — hæmorrhages into skin, retinæ, and from nose and gums	2. 5.27	1,337	2,600	28	?	?	
	6. 5.27 Transfusion						
	7. 5.27 Transfusion						
	12. 5.27	1,659	1,800	33	38,000	?	
	17. 5.27	1,653	1,900	33	8,250	?	
	21. 5.27	..	..	..	6,800		
	25. 5.27	1,680	1,600	35	..	>12	
	8. 6.27	1,536	..	28·5			
	11. 6.27 Transfusion						
	15. 6.27 Splenectomy and Transfusion						
	18. 6.27	..	..	..	45,000		
	22. 6.27	2,010	..	28	96,480		
	28. 6.27	1,570	..	32	47,000		
	7. 7.27	..	..	..	48,000	4½	
	26. 7.27	1,600	..	..	26,000		
	4. 8.27	1,750	..	24			
	13. 8.27 Transfusion						
	17. 8.27	1,200	..	30	16,000		
	27. 8.27 Transfusion	1,560	2,400	22			
	14. 9.27	1,795	2,600	27			
	28. 9.27	1,570	1,800	..	43,600	>15	

	2.5.27	12.5.27	17.5.27
Polymorphs ..	845	288	342
Lymphocytes ..	1,667	1,386	1,502
Large mononuclears	52	72	57
Eosinophils ..	—	18	—
Myelocytes ..	26	36	—

Slight improvement for short time after operation, but continuation of hæmorrhages into skin, gums, retinæ, and nose, for 3½ months after operation. *Spleen:* Normal but for hyaline degeneration in wall of arteries. Many platelets in smear (200,000 per c.mm.)

Died Nov., 1927. Autopsy: Degeneration of heart muscle, liver, and kidneys. Intrapulmonary, subpericardial, and subendocardial hæmorrhages, and hæmorrhages into the renal pelves.

Continued on next page

ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY—*continued.*

AUTHOR AND HISTORY OF CASE	DATES AND OPERATION	BLOOD CORPUSCLES		Hb.%	PLATELETS	BLEEDING TIME	REMARKS
		Red	White				
Case No. 81. Starr[70]		Thousands				Minutes	
No details	Before splenectomy ..	..	..	..	0		Died of pachymeningitis hæmorrhagica. Massive clots over both hemispheres beneath dura
	1 day afr. splenectomy	..	..	..	Very few		
	3 days afr. splenectomy	..	..	..	Very few		
Case No. 82. Steinbrink[71]							
F., age 5	Before splenectomy ..	1,770	12,000	15	1,300	12	5 months after operation: slight epistaxis and petechiæ. General condition good
2½ years — hæmorrhages into skin, and	3. 9.27 Splenectomy..						
from nose and stomach	? after splenectomy ..	..	..	..	8–18,000		
	9 wks. after „ ..	..	26,400	..	++		
	Later	..	..	..	..	5½	
Case No. 83. Sternberg[72]							
F., age 64	Before splenectomy ..	4,620	?	87	62,600	12	No recurrence after 2 months
Chronic hæmorrhage	24 hrs. after „ ..	..	..	..	187,000	1½	
from uterus and into	2 days after „ ..	..	..	..	78,000	4	
skin	3 days after „ ..	..	..	..	68,000	4	
	6 days after „ ..	..	..	..	91,800	4	
	11 days after „ ..	..	..	..	129,000	5	
	20 days after „ ..	..	..	..	130,000	6	
	2 mths. after „ ..	..	..	..	109,000	5	
Case No. 84. Sternberg[72]							
F., age 64	Before splenectomy ..	4,120	?	85	36,000	20	Bleeding recurred in 2 months. Result poor
1 year—purpura	24 hrs. after „ ..	..	..	..	187,00	1½	
Case No. 85. Sutherland and Williamson[73]							
F., age 8	Mar., 1923	5,000	45,000	98			Petechiæ and ecchymosis still occasionally occur after 8 months. No external bleeding. *Spleen:* Malpighian corpuscles prominent. Great diminution in number of lymphocytes, and marked endothelial proliferation in Malpighian bodies and sinuses. Connective tissue of sinuses swollen and hyaline. No blood-platelets
3 years — hæmorrhages into skin and	Apr., 1924	4,500	..	65			
conjunctiva and from	9. 6.24	5,300	35,000	50	18,000		
nose and stomach	18. 6.24	5,000	12,000	50	15,000		
	19. 6.24 Splenectomy						
	23. 6.24	4,800	30,000	40	30,000		
	30. 6.24	..	18,000	45	40,000		
	8. 7.24	..	12,000	48	120,000		
	15. 7.24	..	20,000	60	160,000		
	30. 7.24	..	18,000	60	140,000		
	8. 9.24	..	15,000	60	30,000		
	5.11.24	..	15,000	75	125,000	5½	
Case No. 86. Sutherland and Williamson[73]							
M., age 9	Jan., 1924	1,500	20,000	20	..	15	5 months after: no recurrence of hæmorrhages. *Spleen:* as in No. 85
6 months — hæmor-	1. 5.24 ..	2,600	10,000	20			

	5.11.24	..	15,000	75	125,000	3½	

Case No. 86. Sutherland and Williamson[73]

M., age 9	Jan., 1924	1,500	20,000	20	..	15	5 months after: no recurrence of hæmorrhages. *Spleen:* as in No. 85
6 months — hæmorrhages into skin and from nose, bowel, and stomach	1. 5.24	2,600	10,000	20			
	2. 6.24	3,200	..	28	5,000		
	29. 6.24	5,200	15,000	45	5,000		
	3. 7.24 Splenectomy						
	9. 7.24	4,000	..	40	150,000		
	16. 7.24	4,500	..	40	180,000		
	14. 8.24	5,500	..	70	350,000		
	14.10.24	4,500	..	70	200,000	Normal	

Case No. 87. Tietze[76]

F., age 5	Before operation ..	..	..	..	8,300	20	Once slight epistaxis, since then no recurrence
Purpura and epistaxis	1 hr. after ,, ..	..	..	..	11,000		
	18 hrs. after ,, ..	..	..	..	11,000		
	1 week after ,, ..	..	..	..	30,000	6–8	

Case No. 88. Vincent[78]

F., age 64	Before splenectomy ..	..	..	..	Very few		10 months after: no recurrence
Chronic purpura	3 days after ,, ..	..	..	..	Normal	7	

Case No. 89. Vincent[77]

F., age 28	Apr., 1922	2,712	7,600	35	1,000	?	
17 years — hæmorrhages into skin and from gums, nose, retina, and uterus ..	Apr., 1924	4,000	5,800	75	Very few	40	
	23. 4.24 Splenectomy	..	..	..	..		
	6 hrs. after ,, ..	..	12,000	..	No change		
	24 hrs. after ,, ..	..	16,000	..	Slightly below normal		
	30. 4.24	..	..	..	Normal		
	8. 5.24	4,320	7,800	..	Normal		
	16. 6.24	3,900	6,200	80	Slightly below normal	3	
	13. 4.25	4,480	7,800	85	Normal	Normal	

	April, 1922 per cent	April, 1924 per cent	April, 1925 per cent
Polymorphs ..	75	65	71
Lymphocytes ..	18	27	20
Large mononuclears	7	8	8
Eosinophils ..	—	—	1

1 year after operation: no recurrence. *Spleen:* infiltration of reticulum with small round cells resembling lymphocytes, and collections of large lymphocytes in follicles

Case No. 90. Vincent[77]

F., age 13	?	2,284	9,000	33	0	1 hr. +	
2 years — hæmorrhages from nose, skin, and gums	22. 2.24	2,380	10,000	40	Very few	12	
	23. 2.24 Splenectomy						
	24. 2.24	..	..	..	Increased	..	
	25. 2.24	..	..	..	..	2½	
	2. 3.24	..	..	..	Above normal		
	11. 3.24	3,896	13,400	..	Normal		
	18. 3.24	5,104	..	65	Slightly reduced		
	1.11.24	..	..	..	..	3	
	1. 4.25	4,800	20,000	80	4–5 times normal	Normal	

	Before Splenectomy per cent	1.4.25 per cent
Polymorphs ..	66	71
Lymphocytes ..	20	24
Large mononuclears ..	9	4
Myelocytes	5	—
Eosinophils	—	1

9 months after operation: slight epistaxis twice. 14 months after: no recurrence. *Spleen:* weight, 157 grm. Hyperplasia of cells of lymphocyte series. No myeloid elements. No nucleated reds. Occasional megakaryocytes. Eosinophils fairly common

Continued on next page

ABSTRACT OF 101 CASES OF PURPURA HÆMORRHAGICA TREATED BY SPLENECTOMY—*continued.*

AUTHOR AND HISTORY OF CASE	DATES AND OPERATION	BLOOD CORPUSCLES		Hb.%	PLATELETS	BLEEDING TIME	REMARKS
		Red	White				
Case No. 91. Vincent[77]		Thousands				Minutes	
F., age 14 .. .. 5 years — hæmorrhages from nose, skin, gums, and uterus	Before splenectomy ..	3,464	9,600	35	Very few	45	11 months after: no recurrence. *Spleen:* weight, 135 grm. Fibrosis of pulp. Follicles numerous. Occasional megakaryocytes in sinuses. Hyperplasia.
	26. 5.24 Splenectomy						
	3 days after ,, ..	..	..	..	Normal	Normal	
	11 days after ,, ..	..	..	..	½ normal		
	5 mths. after ,, ..	..	..	..	Sl. dim.	4½	
	11 mths. after ,, ..	4,880	7,000	80	2–3 times normal	Normal	
Case No. 92. Vincent[77]							
F., age 6 .. .. 2 months—epistaxis	Before splenectomy ..	3,240	7,200	60	0	18	4 months after: no recurrence. *Spleen:* increase of connective tissue of reticulum with hyperplasia of lymphoid cells of sinuses of pulp. No evidence of hæmatopoiesis. Lymph nodes do not show prominent germinative centres. Hyperplasia
	18.12.24 Splenectomy						
	2 days after ,, ..	..	..	..	Dim.		
	8 days after ,, ..	4,960	8,500	90	Normal	3	
	4 mths. after ,, ..	5,440	7,200	85	Mod. increased	Normal	
Case No. 93. Vogel[79]							
M., age 12 .. .. 7 years — hæmorrhages from nose, skin, and rectum	Before splenectomy ..	?	?	..	25,000	90	10 months after operation: no recurrence of hæmorrhages
	Shortly after ,, ..	..	..	..	No increase		
	10 mths. after ,, ..	..	..	..	20,000	Normal	
Case No. 94. Vogel[79]							
F., age 17 .. .. 1 year — hæmorrhages from nose and uterus	Before splenectomy ..	..	..	..	0	25	14 months after operation: no recurrence of hæmorrhages
	14 days after ,, ..	..	..	..	900,000		
	14 mths. after ,, ..	..	..	..	32,000		
Case No. 95. Waugh[80]							
No details	After splenectomy ..	..	..	..	155,000		2 months after: no recurrence
Case No. 96. Whipple[81]							
M., age 18 .. .. 4 years — hæmorrhages into nose, skin, and gums	Before splenectomy ..	4,200	..	65	0	12	4 months after: no recurrence. General health very good
	1 day after ,, ..	..	..	..	50,000		
	2 days after ,, ..	..	..	..	80,000	3	
	3 days after ,, ..	..	..	..	180,000		
	9 days after ,, ..	..	..	..	10,000		
Case No. 97. Whipple[81]							After operation, occasional petechiæ, one epi-

	9 days after „ ..	..	..	..	10,000		
Case No. 97. Whipple[81]							
F., age 47	Before splenectomy ..	4,400	?	75	>5,000	8	After operation, occasional petechiæ, one epistaxis, some bleeding from gums. Much stronger. Follow-up for 3½ months
Many years —hæmorrhage into skin, nose, and gums	1 day after „ ..	..	..	..	25,000		
	2 days after „ ..	..	..	..	30,000		
	6 days after „ ..	..	..	..	100,000	1½	
	8 days after „ ..	..	..	..	30,000		
	3½ mths. after „ ..	..	..	..	10,000	18	
Case No. 98. Whipple[81]							
F., age 25	Before splenectomy ..	3,300	..	53	15,000	4	Still in hospital at time of report with post-operative massive collapse of lung. No recurrence of hæmorrhages
Many years — hæmorrhage into skin and uterus	3 days after „ ..	..	..	..	35,000		
	5 days after „ ..	..	..	..	65,000		
	6 days after „ ..	..	..	..	40,000		
Case No. 99. Whipple[81]							
F., age 42	Before splenectomy ..	3,000	..	50	4,000	8	Patient died in another hospital one hour after operation
4 weeks — hæmorrhage into skin, nose, and gums							
Case No. 100. Wild[82]							
M., age 15	Before splenectomy ..	2,400	..	36			9 months after operation: no recurrence of hæmorrhages
Since childhood—purpura. Admitted immediately with rupture of spleen ..	7. 6.22 Splenectomy						
	Immediately after splenectomy ..	..	..	..	92,500	5	
	8. 6.22	..	..	..	81,000	6½	
	12. 6.22	..	..	..	324,000		
	20. 6.22	..	..	..	1,033,000		
	14. 7.22	..	..	..	8,200,000	2	
Case No. 101. Wittkower[83]							
M., age 15	Dec., 1922	..	..	..	50,000		No recurrence of hæmorrhages 6 months after operation
Epistaxis and hæmoptysis	May, 1925	..	..	..	30,000	12	
	4. 9.25	..	..	..	34,500	16½	
	16. 9.25 Splenectomy						
	½ hr. after splenectomy	..	..	..	68,300		
	17. 9.25	..	..	..	152,000		
	18. 9.25	..	..	..	168,000		
	23. 9.25	..	..	..	895,000		
	16.10.25	..	..	..	170,000		

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SPECIAL ARTICLES ON SURGICAL TECHNIQUE.

SURGICAL DIATHERMY IN BREAST CANCER:*

THE APPLICATION OF THE ARC ELECTRODE OR CUTTING CURRENT TO THE RADICAL OPERATION.

By JOHN ANDERSON,

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When we review the follow-up and end-results of the radical operation for cancer of the breast we realize that there is great room for improvement. Leitch[1] estimates that only 10 per cent of operated cases will be alive after ten years, and we all have had our disappointments in viewing recurrence in cases we had looked on as early, accessible, and removable cancer.

Until some specific method of dealing with the cancer cell has evolved, it seems that we must concentrate on propaganda and improvement of operative procedure. It does not appear possible to extend the anatomical limits of the present-day operation; but anything which will improve its technique appears sound.

The arc electrode has been used to replace the scalpel in all my operations for mammary cancer during the last four years, and the results over that period seem materially better than those obtained when using the scalpel.

I have avoided putting my findings into print at an earlier date because I fully realize that even four years is far too short a period to form a convincing opinion on the subject of mammary cancer when the end-results are incomplete and must remain so for years to come, but I have convinced myself, and I venture to think certain colleagues whose opinion I respect, that the procedure is (1) safe, and (2) a distinct advance on the scalpel dissection of neoplastic disease, and worthy of investigation and control by other workers. Much work has been done recently on the same lines by G. A. Wyeth and Howard A. Kelly, and their opinions seem voiced in the following quotations from their reports:—

Wyeth[2] says: "Operating on a case of tumour of the bladder, the usual incision was made by the scalpel. The growth was thoroughly exposed by electric light in the bladder and treated after the technique of monopolar endothermy. The bladder was sutured in the usual way, without drain.

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* The method and results here reported have been secured by team work, in which I have been responsible for the surgical part, Dr. G. H. S. Milln for the electrical, and Dr. J. M. Clark for the anæsthetic.

"After three months, cystoscopic examination showed that the site of the lesion was free and clean. So smooth had been the healing that it was difficult to be sure just where the growth had been, but on turning the beak of the cystoscope upward the observer was amazed to see along the line of the scalpel's incision three carcinomatous nodules. There could hardly be a more graphic picture of the beneficent healing action of the high-frequency current as contrasted with the lack of protection against implantation provided by the scalpel."

Writing on endothermy as 'the new surgery', Howard A. Kelly[3] says: "In the old-fashioned, bloody surgical operations commonly in vogue, I now begin to think with repulsion of the messiness of the procedure, the sponging, the tying, the needling, and the general manipulations of the wound which must contribute to so many bad results. I therefore welcome this new method of coagulation as a great addition to our technique, not only enabling us to do some things better, but greatly enlarging our field of beneficent activity. I give the Wyeth sector the leading place and decided preference in my daily work, relegating the scalpel to a subordinate position."

It has been long recognized that the cancer cell is more vulnerable to heat than the normal cell. Therefore electrothermic methods offer greater security against recurrence, as they produce a maximum destruction of neoplastic tissue.

A. C. Scott[4] uses an electric cautery for radical excision of the breast, and his results, as reported to the American Medical Association in 1925, are absolutely outstanding. The arc electrode appears to have all the advantages of the actual cautery without its disadvantages.

In September, 1923, while on a visit to Stockholm, I saw at the Radium Institute (Professor Gôsta Forssell) a case of cancer of the breast excised by the 'diathermy knife'. This type of section of tissue was new to me, though I had previously practised excision of the tongue with a heavier electrode (electro-coagulation). The operation I saw on that occasion was not so extensive as I practise with the scalpel. The skin was widely excised and the chest wall was cooked by button coagulation, no attempt being made to dissect back flaps and suture the skin. I determined to investigate the possibilities of applying the method to the operation which we practise.

On my return to work, I consulted with Dr. G. H. S. Milln, our senior medical electrician, and we immediately set about a series of experiments with the machines available. We very soon found that the small machine made by Schall for medical diathermy produced an excellent 'cutting' current with the knife electrode, which I purchased from Stille, of Stockholm.

APPARATUS EMPLOYED.

The apparatus that we use (*Fig.* 362) is made by Messrs. Schall & Son, No. 6180, and is built for 200 volts D.C.* Its weight is 62 lb., and it costs

* Dr. Milln communicates that a new portable diathermy apparatus has been designed by Mr. Schall which works off alternating current of voltage from 100 to 150 and produces a low-voltage current, and that it appears to cut with equal efficiency.

£38. We have tried many other diathermy machines, but find that they either do not cut at all or only 'cleave' feebly and produce excessive coagulation.

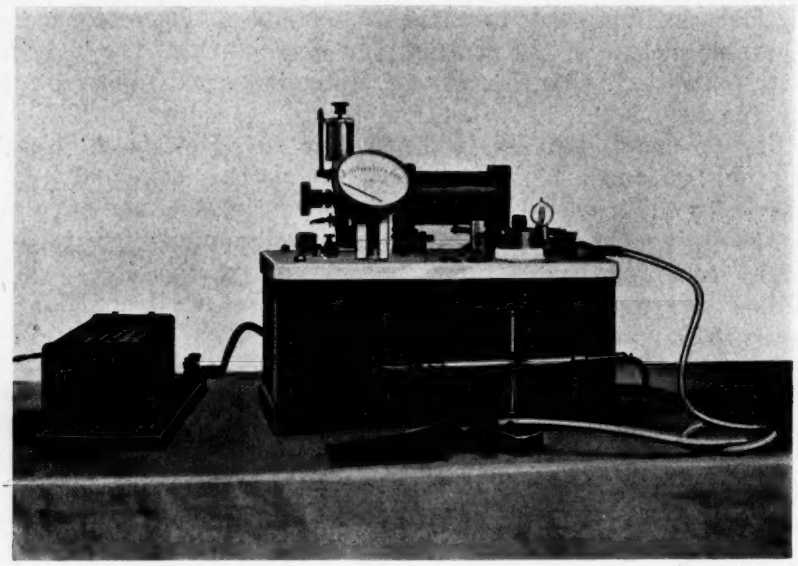
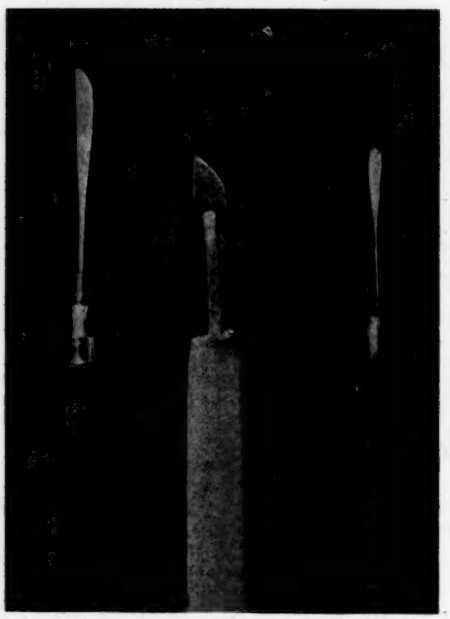


FIG. 362.—Diathermy apparatus, No. 6180 (Schall & Son).

Electrodes.—We have used several different types of active electrodes (*Fig.* 363).



a *b* *c*

FIG 363.—Various types of electrode.

1. The small platinum knife shown in *Fig.* 363, *a*, which I purchased from Messrs. Stille, of Stockholm.

2. A Bard-Parker knife with a terminal holder welded to the handle and with a blunted blade. The handle of this knife was insulated with rubber tubing (*Fig.* 363, *b*). We found that arc dissection could be better carried out by using the back of the knife than with the sharp edge of the blade. Rubber tubing of considerable thickness must be used for insulating this handle, otherwise there appears to be escape of electrical energy and irregular current.

3. A fine needle used with the ordinary vulcanite handle.

4. Recently we have obtained a new handle made of amber-coloured glass (*Fig.* 363, *c*), which is attached to a sterilizable cable, and to which can be

applied white metal blades. The whole of this electrode and its attachments are sterilizable. (The General and Radiological Surgical Apparatus Co., Great Portland Street, London.)

The advantages of No. 4 appear to be that the handle is powerfully insulated, and that both it and the lead are sterilizable. In our earlier work we sterilized the blade and covered the vulcanite handle with colostomy tubing. This method always left a sense of insecurity, in that there was a greater possibility of error in technique. The fine white metal points supplied with this electrode must not be used directly on the indifferent electrode for the purpose of testing efficiency of current, as one is liable to fuse the metal of the active electrode.

Type of Current Used.—Considerable diversity of opinion still exists amongst electrical experts as to the exact type of current produced by the

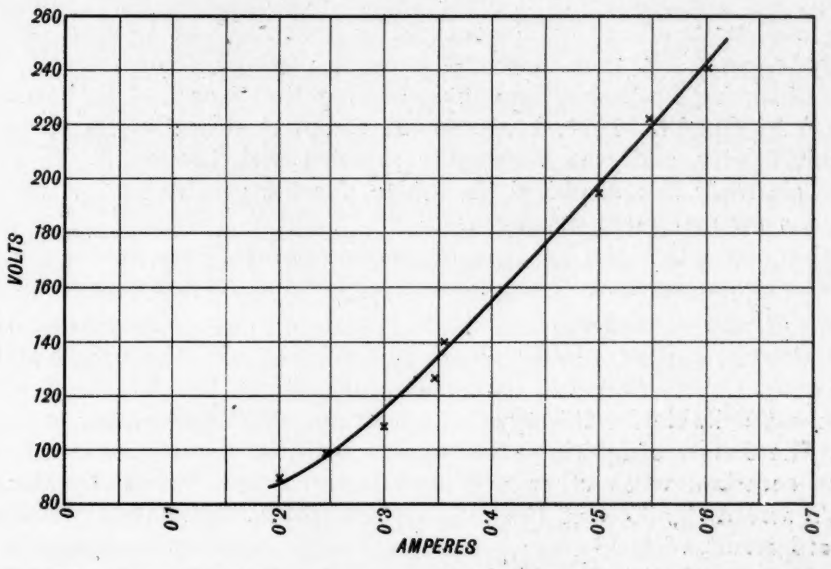


FIG. 364.—Curve showing the voltage across the terminals 0–3, with currents through the patient from hand to hand.

various diathermy machines, and it appears that much of the knowledge, even to-day, is empirical.

The machine 6180 (Schall) produces a good cutting current apparently because it has the requisite strength (amperage) and a comparatively low voltage, and the oscillations reach the patient well sustained and undamped in character. The voltage varies quite considerably with the output, and I attach a chart (*Fig.* 364) made for me by Mr. W. E. Schall, B.Sc., showing this variation.

The amount of current actually passing during cutting is small, not more than 0·05 of an ampère. When sealing with prolonged contact amperage rises to 0·1 or 0·2.

From this machine various effects can be obtained by using it in different ways: (1) Bipolar cutting current by arc. The current is turned on *before*

applying the active electrode; (2) Bipolar electro-coagulation of tissue by turning on the current *after* contact is made; (3) Monopolar coagulation or desiccation—a less violent form of (2).

Monopolar is probably a misnomer, as the patient is connected through the earth, and that and any intervening insulating material is merely acting as a condenser.

Colleagues who failed to obtain the 'cutting current' were found to be using an apparatus which produced a good medical, rather than surgical, diathermy effect, probably because of its less frequent oscillations and higher voltage.

TECHNIQUE.

At first we employed the method on dead tissue and became familiar with the regulation of current and manipulation of the electrode. We found later, however, that in dealing with living tissues other factors came into play—namely, resistance offered by the circulating body fluids and retraction of live tissue when cut. I then removed a small non-malignant tumour of the breast, dissecting back skin-flaps and suturing the wound. The healing was perfect. In October, 1923, I attempted complete dissection of the breast, as detailed later, and was thoroughly satisfied with the result. Since then the arc electrode has displaced the scalpel for the greater part of all breast dissections for malignant neoplasm.

Before operation the patients are examined by X-ray screen for metastasis in bone or thorax. The patient is prepared as for the scalpel operation.

Anæsthesia.—One hour previous to operation a dose of morphine-atropine is administered hypodermically, the dosage varying with the weight and type of the patient. We find that light chloroform or gas and oxygen anæsthesia is the most suitable for this type of operation. Our reasons for this are:—

1. The danger of igniting ether vapour with the electric arc is a real one. On one occasion, when ether was used under a tent formed by the anæsthetist's screen, ignition of the vapour took place, fortunately without any untoward result.

2. My anæsthetist, Dr. Clark, has discovered that a very much lighter anæsthesia suffices than for the scalpel operation.

3. Before we used the arc method for excision of the breast we diverged from our routine and adopted chloroform for a considerable portion of the anæsthesia, as we found the bleeding much less, and consequently, with the lessened loss of body fluid and manipulation, shock was diminished.*

Making the Incision.—The machine is worked by a technician from the Electrical Department. It is linked up with the direct current, 220 volts, and with the coal-gas supply. Where coal gas is unobtainable, spirit can be used to produce the flame. The indifferent electrode, consisting of a sheet of

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* On several occasions, in the earlier stages of our work, the anæsthetist received appreciable electric stimulus conveyed through the patient to the metal mask. Although this was no more than disturbing, he found it preferable to wear rubber gloves in order to prevent the occurrence.

I have found local anæsthesia unsatisfactory, as the patients experience discomfort at the time of contact and withdrawal.

tinfoil plate, about 6 in. by 4 in., is moulded to the wrist of the affected side and kept in place by a flannel bandage, the metal being applied directly to the skin. In our earlier cases this electrode was applied under the trunk, the patient simply lying on it. I came to the conclusion, however, that irregularity of current was produced with the slight body movement that is associated with deep breathing under anæsthesia.

The arm is supported in abduction by a nurse. The active electrode, holder, and cable, all previously sterilized, are attached to the opposite terminal of the machine, and the cable is held in position over the right shoulder of the operator by means of a safety-pin through the operator's gown. The current is then turned on by the technician and the active electrode is drawn across the line of the desired incision. A fine arc appears just as the electrode touches the skin, and the tissue is 'cleaved' to a depth varying from a fine line to 1 cm. according to the strength of the current used and to the resistance of the tissue approached. The blade of the electrode is carried rapidly along the line of the desired incision, and the tissues appear to fall apart in front of the blade. The cleaved edges seem to be covered with a fine grey membrane which is just visible to the naked eye.

Hæmostasis.—All the capillary vessels and the lymphatics are sealed during the above procedure, but the larger vessels require to be clamped with hæmostatic forceps. These larger vessels are dealt with later by holding up the forceps and making contact near their joint with the active electrode. This actually converts the forceps into the active electrode, and the vessels are sealed off by electro-coagulation. At the slightest sign of bleaching or sizzling of the tissues contact should cease, as it is possible that if the coagulation is overdone sloughing or protein shock may occur, though neither has been seen in this group of cases. This is an extremely efficient and rapid means of hæmostasis, and with a little practice the operator soon finds the exact amount of contact required to produce the desired degree of coagulation. From experience we find that a slightly stronger current is better for vessel coagulation than for skin cleaving.

Operation.—It seems unnecessary to detail exactly the operative procedure, as each individual surgeon can apply the method to replace the scalpel dissection in his operation of choice. Our routine is as follows: The current is turned on. With the active electrode, arc cutting current the tumour is lightly outlined—with a weak current so as merely to scratch the skin just beyond its palpable limits. With a similar current the skin incision is traced on the skin wide of the tumour from over the sheath of the rectus abdominis to the upper third of the upper arm.

The skin-flaps are dissected back to expose the sternum, the clavicle, and the latissimus dorsi. A fine layer of fat is left attached to the skin. The operative field is remarkably dry and free from blood, as all the capillary vessels and lymphatic channels are sealed as excised. The larger vessels are picked up with hæmostatic forceps.

It is important to use the electrode lightly in a series of short, rapid sweeps, as delay will cause the current to be altered from the cleaving towards the coagulating type, and tissue will be altered to a greater depth than is desirable for good repair.

Deep dissection is commenced at the upper part of the origin of the pectoralis major. The insertion of the minor is then dealt with in the same way, and the axilla is cleared. On approaching the axillary vessels and nerves, I usually rest the electrode and proceed to dissect in this area with the scalpel. I have in two cases been able to dissect the axilla completely with a needle electrode, also cutting down current to a minimum; but, as a rule, when one brings the charged electrode near to a nerve, violent jerking occurs and it is difficult to regulate the depth of electrothermic dissection. The vessels coming directly off the axillary vein and artery are best treated by forceps and ligature because: (1) Coagulation so close to the main vessel

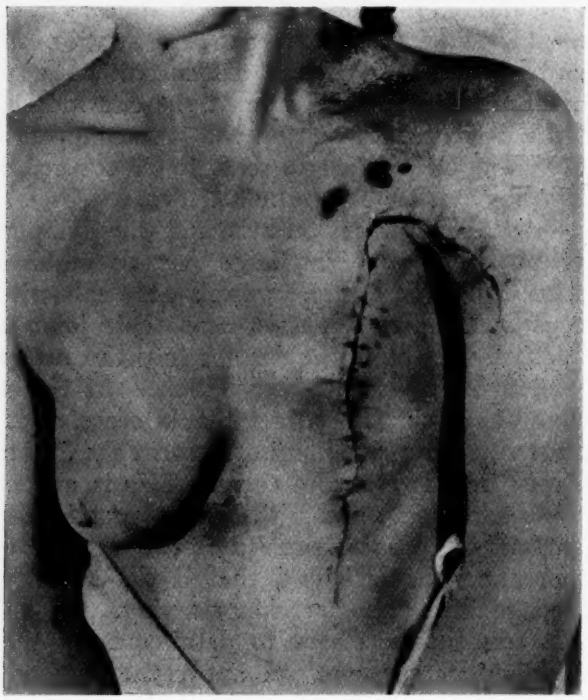

FIG. 365.—*Case* 60. Appearance of the scar 15 days after operation. The figure also shows the result of an error in technique—three areas of too closely flayed skin.

may cause thrombosis; and (2) Jerking may occur owing to electrical stimulation of a nerve.

The twitching of muscles on application of the electrode would seem at first sight impossible with such frequent oscillation, but it has been explained as being due to 'undertones' of these oscillations and not to the oscillations themselves.

The ligatures mentioned above, eight to ten in number, are the only ones required in the operation. Having cleared the axilla and long subscapular nerve, the electrothermic excision is again used to remove the breast, pectorals, rectus sheath, etc. All the bleeding points which are not sealed are seized by fine artery forceps and coagulated by contact.

The Comparative Resistance of Tissue.—The speed and depth of section varies with the amount of current and the resistance of tissue. *Fat* offers the greatest resistance to passage of the current, and therefore requires heavy output. *Cartilage* appears at the other end of the scale, and care must be taken in dissecting the pectoral muscle from the rib cartilages, as it is easy to allow the 'knife' to 'fly' through this tissue. *Muscle* is the next most rapidly cut. *Skin* is intermediate between muscle and fat. *Bone* can be cooked but not cut.

The current is controlled by a lever handle which registers on a scale. The technician working the apparatus can adjust the current very accurately to the amount of output required at the various stages of the operation, e.g., a large current when sealing vessels and a small current when cutting muscle.

Skin can be too closely flayed —in fact, buttonholed—with diathermy current, as *Fig.* 365 shows.

The important points in technique seem to be: (1) Careful regulation of current according to the type of tissue being cut at the time. (2) The ordinary sense of resistance of tissue to the scalpel is not felt with the arc electrode; therefore, it is essential to become familiar with the cleaving action on dead tissue. This is easily and rapidly learnt. (3) The electrode must be kept *moving lightly* over the tissues. Delay would cause undue coagulation. (4) The active electrode should be occasionally cleaned by scraping with a blunt scalpel, as blood-clot coagulates on it and lessens the 'sharpness' of the arc.

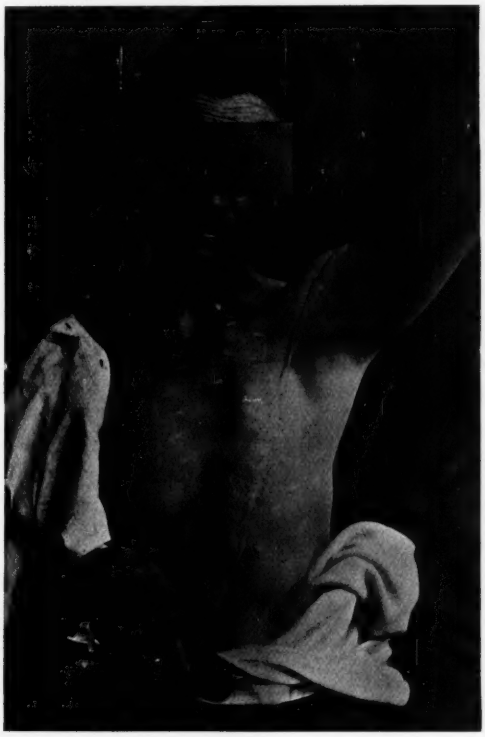

FIG. 366.—*Case* 2. Showing the wide scar following the use of the heavy electrode. Operation Jan. 8, 1924.

Closure and Healing of Wounds. —The skin-flaps are brought together as in the scalpel operation and closed by sutures and clips. In a few of the early cases hæmostasis was so perfect that no drainage was provided, but now I drain as a routine, and, although very little blood serum comes away as a rule, one provides for the exceptional case by inserting a portion of rubber dam through a lateral stab wound. The small hæmatoma which is occasionally noted after the scalpel operation is seldom seen with this method. With almost unfailing regularity the healing occurs by first intention, and with a fine, soft scar; personally I have been able to obtain better healing by this method than with the scalpel. In one or two cases where I used a heavier electrode, the 'desiccated' area was thicker than

what we now obtain, and the scars were broader and less pleasing to look on (*Fig.* 366). The healing appears to proceed at the same pace as in scalpel operation, but in two cases where I produced a slight charring of the skin, on account of the machine giving a less perfect cutting current, there was a

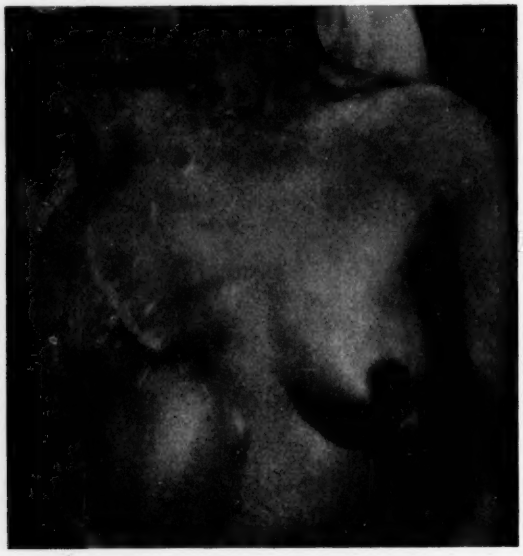

FIG. 367.—*Case* 6. Fine scar caused by the use of the platinum knife. Operation June 9, 1924.

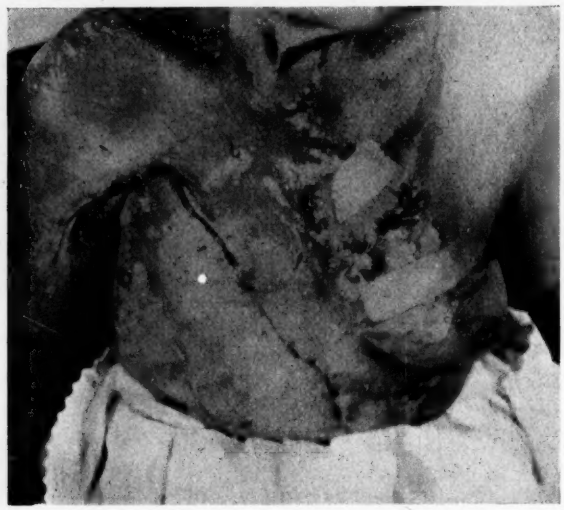

FIG. 368.—*Case* 61. Appearance of scar 27 days after operation. The discoloration of the skin is due to picric acid used in preparation.

little gaping of the wound on removal of the stitches on the eighth day. In two cases when the needle electrode (in place of the knife electrode) was used right through the operation, the scars were slightly broader and tended to

gape in small areas. Union, however, occurred in these without suppuration and without any apparent protein shock. In two cases a certain amount of infection occurred in the wound—one rather extensive streptococcal, and one localized staphylococcal. Both cases healed with good scars, and I am of the opinion that the error occurred during the manipulation of the covering of the active electrode with its sterilized sheath.

HISTOLOGY.

Dr. Tudhope reports that the tissue from the cut surfaces of breasts removed by the diathermy method has been examined microscopically, portions having been selected from skin (*Fig.* 369), adipose tissue (*Fig.* 370), muscle (*Figs.* 371, 372), and epithelioma of the lip (*Fig.* 373).

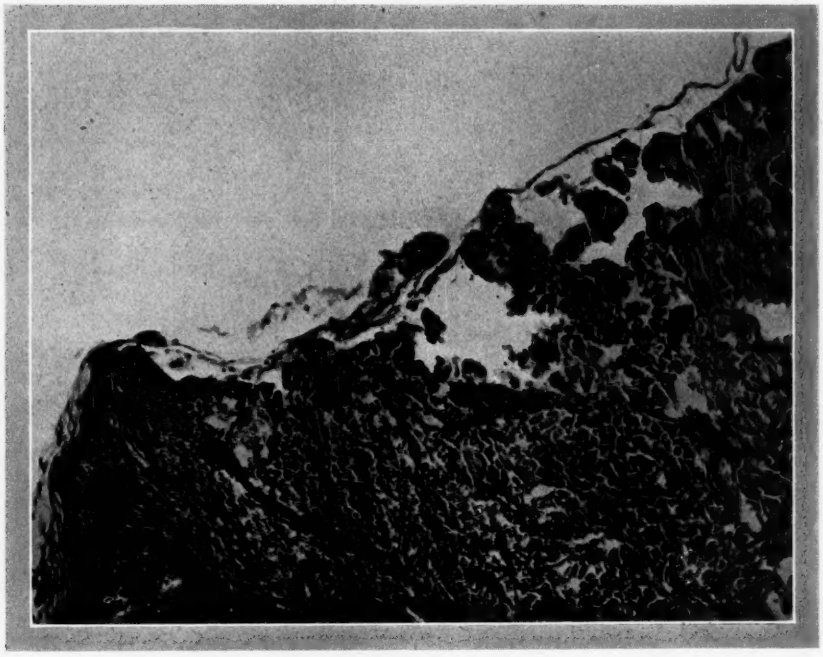

FIG. 369.—Skin of breast after section by the arc knife. Hæmatoxylin-eosin stain. (× 75.)

The sections have been prepared by the paraffin method from tissue fixed in formalin, and stained with hæmatoxylin and eosin. One section (*Fig.* 371) has been stained by the iron-hæmatoxylin method devised by Heidenhain.

In all the tissues the changes appear to be of the same nature. The surface cut by the diathermy knife shows superficially a thin membranous layer in which no cellular elements are noted. It suggests collapsed and desiccated areolar tissue. Here and there small masses of coagulum are attached to the surface of this layer. Beneath this is a broader tract of altered tissue, extending inwards up to $\frac{1}{10}$ mm. The cells here are shrunken;

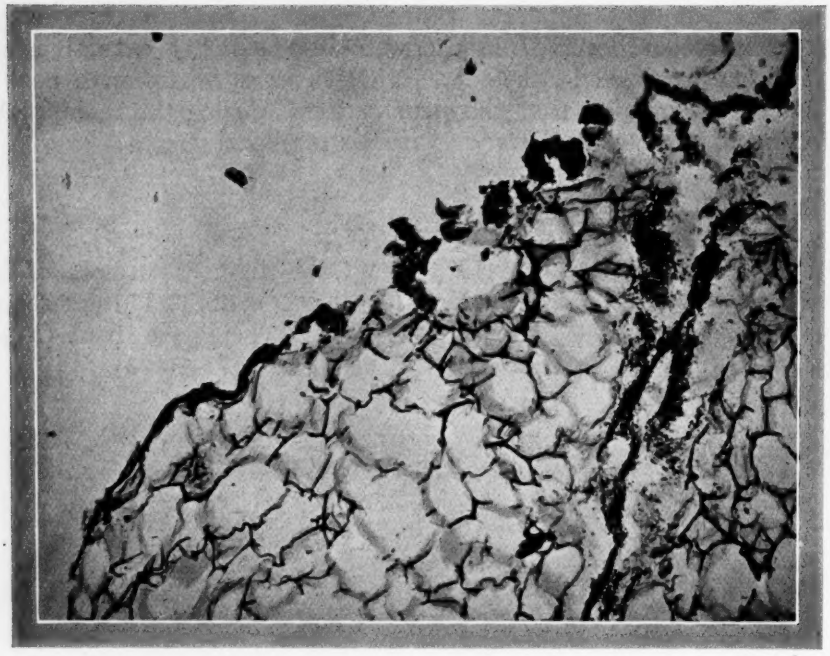

FIG. 370.—Adipose tissue of breast after section by the arc knife. Hæmatoxylin-eosin stain. (× 75.)

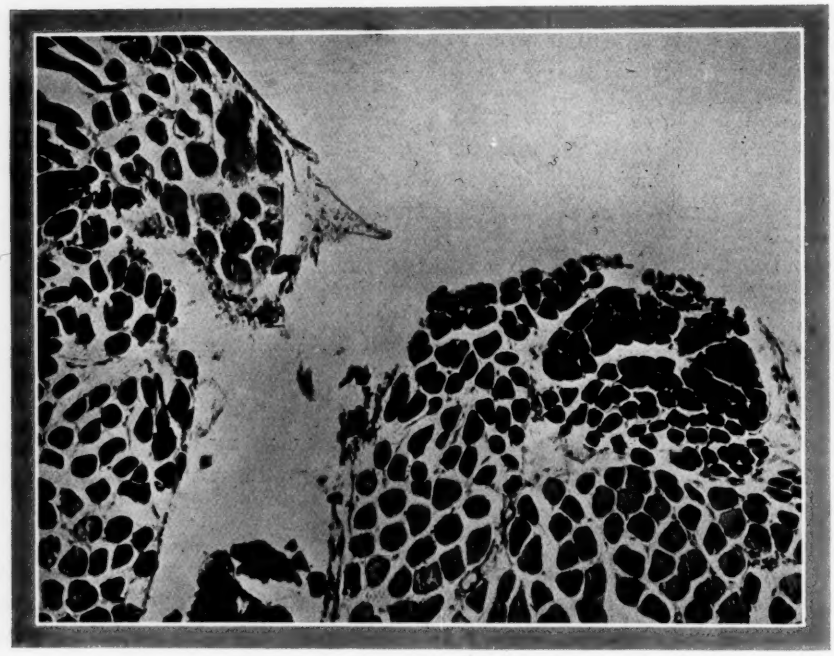

FIG. 371.—Pectoral muscle after section by the arc knife. Heidenhain's iron-hæmatoxylin stain. (× 75.)

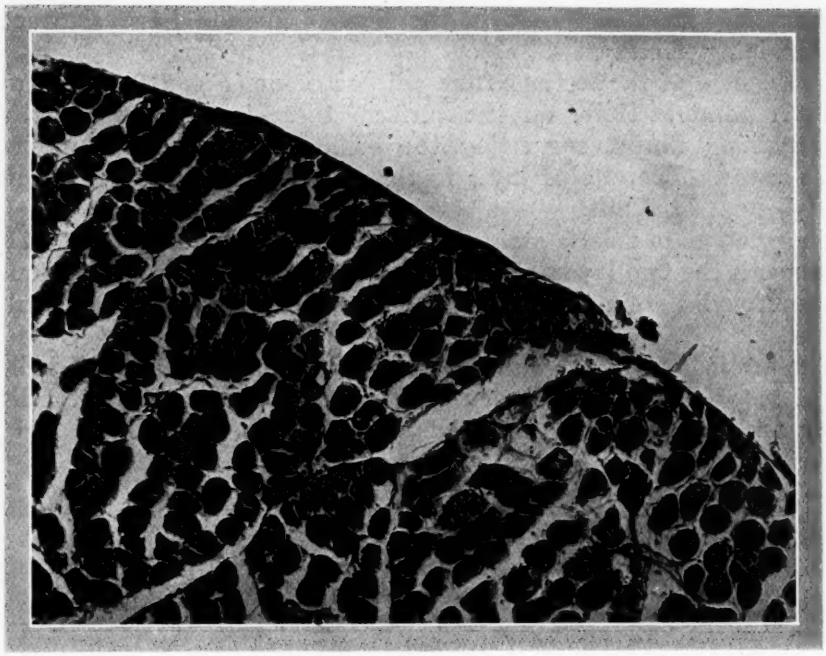

FIG. 372.—Pectoral muscle after section by the arc knife. Hæmatoxylin-eosin stain. (× 75.)

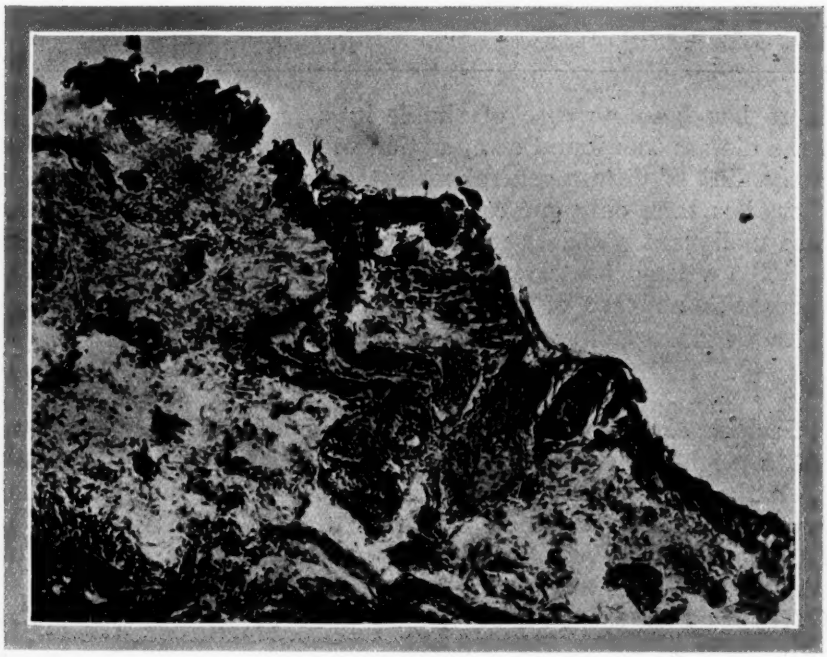

FIG. 373.—Carcinoma of lip after section by the arc needle. (× 75.)

the protoplasm is opaque and granular and tends to take a dark tint with hæmatoxylin. Epithelial cells in the line of incision have contracted and deeply-staining nuclei.

In the case of the sections from adipose tissue (*Fig.* 370) these two layers are not separate. Here, on the surface, there is a narrow meshwork of deeply-staining fibrils, suggesting the collapsed and altered meshwork of adipose tissue. The altered layer in this case is much narrower, being only about $\frac{1}{50}$ mm. in depth.

The section of muscle stained by Heidenhain's method (*Fig.* 371) shows that beneath the two layers mentioned there is a wider tract of tissue where the hæmatoxylin stain is firmly retained, although no morphological change is noted.

The sections from the tumour of the lip (*Fig.* 373) show a well-marked layer of blood-clot on the diathermy surface. Beneath this the cells of the tumour are shrunken and flattened and many show distorted and deeply-staining nuclei.

RESULTS.

RECORD OF CASES OF CARCINOMA OF THE BREAST EXCISED BY THE ARC ELECTRODE 1923–26.

PARTICULARS OF PATIENTS OPERATED ON	ALIVE WITH METASTASIS	DIED FROM METASTASIS	DIED FROM OTHER CAUSES	ALIVE AND APPARENTLY WELL
Glands involved .. 41	2	8	1	30
Glands appeared free .. 15	1	1	0	13
Total .. 56	3	9	1	43

There has been no case of simple local recurrence; but two cases, in which the disease was found at operation to be beyond the range of excision, ultimately died of diffuse general metastasis with local and general nodules.

There has been only one case of appreciable œdema of the arm, and in this case malignant glands were found adherent to the axillary vessels and nerves. The œdema has now receded and the patient appears well.

There was no case of secondary hæmorrhage or of protein shock.

SUMMARY.

1. Scalpel dissection is replaced by the arc electrode except in the immediate neighbourhood of the main vessels and nerves of the axilla.

2. At the time of section all lymphatics are sealed, thus preventing manipulative dissemination of cancer cells from the excised mass.

3. All small blood-vessels are sealed at the time of section, thus obtaining less manipulation and less loss of body fluid.

4. The wounds are sterilized at the time of section, and probably less culture medium is left in the wound.

5. Body heat is kept up in the form of medical diathermy.

6. Less catgut is implanted in the wound, only six to ten ligatures being required.

7. There is less post-operative pain and very much less shock.

8. The operation is more rapid and a cleaner procedure than in scalpel dissection.

9. Healing has proved more satisfactory.

10. Recurrence appears less frequent.

11. The method is used by me for all tumours of the skin and soft parts, tumours of the bladder, hæmorrhoids, and tumours of the lip and mouth. I also use it for biopsy, and here consider that it overcomes the danger that one always recognizes in scalpel excision.

I wish to express my appreciation to Dr. G. Forssell and his colleagues for introducing to me the arc electrode; to Dr. G. H. S. Milln for his continuous advice and help over the whole period of this work; to Dr. Cumberbatch for his generous and valuable advice regarding many of the technical problems; to Dr. Tudhope for preparing the sections and investigating the tissues; to Mr. W. E. Milne for the microphotographic work; and to Mr. John Taylor for following up the cases and acting as a control on the results.

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SHORT NOTES OF RARE OR OBSCURE CASES

CASE OF FRACTURE OF SKULL, FOLLOWED BY THE PRESENCE OF AIR IN THE CRANIAL CAVITY.

By R. D. MOTHERSOLE,

HON. CONSULTING SURGEON TO BOLTON INFIRMARY.

H. M., male, age 41, body-builder, was riding a motor-cycle in a fog on the morning of Nov. 24, 1926, and had a 'head-on' collision with a motor

FIG. 374.—Antero-posterior view of the skull taken on Feb. 2, and showing the air-space. (The skiagram is reversed.)

bus: his face still shows the pattern of the radiator. He was unconscious when picked up, but regained consciousness in the ambulance on his way to Bolton Infirmary.

On admission, fifty minutes after the accident, he was suffering much from shock, there were numerous abrasions of the face, and the right femur, the right radius, and the body of the right scapula were found to be fractured. There was no bleeding from ears or nose, no circumorbital extravasation, and no subconjunctival ecchymosis. On Dec. 1 the right femur was plated by

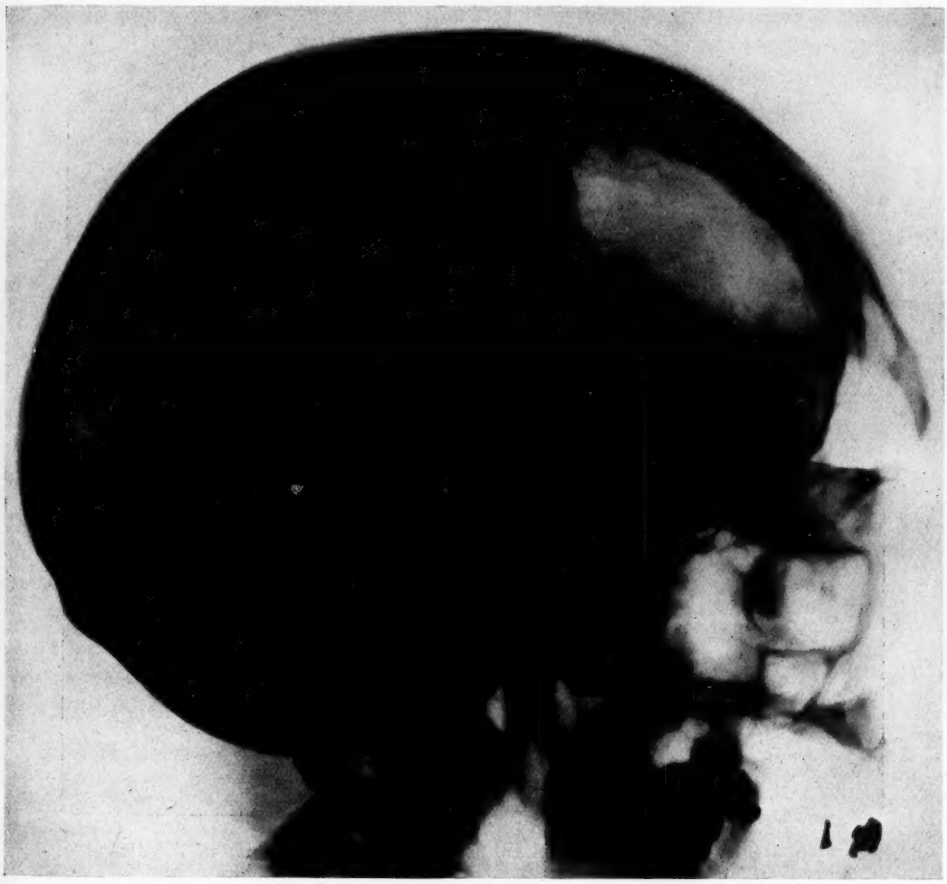

FIG. 375.—Lateral view taken at the same time as *Fig.* 374.

Mr. Leather. The result of the operation was very successful, and the patient was discharged on Jan. 25, wearing a caliper splint. He says that while in hospital he had a running from the nose every morning.

About Dec. 11 he began to be troubled by headaches involving the left side of the vertex; these became much worse after he got home, especially on bending down or if he went out in the cold. For some weeks after the accident there was diplopia. His wife stated that there were also mental changes even while he was in hospital.

On Feb. 1 a slight depression was noticed in the right frontal region,

suggestive of a slightly depressed fracture. Skiagrams were taken on Feb. 2, and showed a remarkable appearance in the right frontal region. There was a pale area roughly circular, and about 2 in. in diameter in the antero-posterior view (*Fig.* 374), oval and 3 × 1½ in. in the lateral view (*Fig.* 375), as if there was much thinning or absence of bone in that region. The antero-posterior view showed the area to approach but not to cross the middle line, the lateral that it was close to, if not immediately below, the frontal bone. The patient was re-admitted to hospital on Feb. 15. His blood was found to give a doubtful Wassermann reaction. Skiagrams taken on Feb. 16 showed a

FIG. 376.—Skiagram taken on April 16, showing the disappearance of the air-space.

very similar appearance to those of Feb. 2. He was discharged on Feb. 28 without operation.

It was suggested by Dr. Sykes, the R.S.O., that the appearance was due to the presence of air inside the skull, and this was proved to be the case on March 10 when the patient told me that he could hear a splash when he shook his head, as he expressed it, " just like shaking a cocoanut ". I could hear the splash quite distinctly as far as three feet from his head, thus getting positive evidence of a cavity containing air and fluid inside the skull. Unfortunately, when I showed the case at the Bolton Medical Society on April 12 the splash was no longer audible, and skiagrams taken on April 16 show no sign of the remarkable appearance seen in the earlier photographs (*Fig.* 376).

From the evidence of the skiagrams and the splash, there can be no doubt that there was a collection of air and fluid inside the skull in the right frontal region. The air must have entered the cranial cavity through a fracture involving the right frontal sinus. One cannot be certain whether the air was internal or external to the dura mater. On the one hand, the sharp definition of the shadow at the middle line in the antero-posterior negative suggests a limitation by the falx cerebri; on the other, the tough dura mater was not likely to be torn by the fracture involving so little displacement of the bone. In my opinion the air was probably extradural. It is possible that frequent shaking of his head to elicit the splash hastened absorption of the air.

By the end of March his head symptoms had much improved, and he returned to work on April 3, but had to leave work again on April 19 with left lobar pneumonia, which disabled him until June 10.

A REMARKABLE EXAMPLE OF THE TENDENCY TO RECURRENT PEPTIC ULCERATION FOLLOWING GASTRO-ENTEROSTOMY FOR DUODENAL ULCER.

BY THE LATE WALTER THOMPSON,
HON. SURGEON TO THE LEEDS GENERAL INFIRMARY;
AND M. J. STEWART,
PROFESSOR OF PATHOLOGY IN THE UNIVERSITY OF LEEDS.

SIR JOHN BLAND-SUTTON, in his Hunterian Oration on jejunal ulcer (1916), speaks in his inimitable way of 'new ulcers for old', but even he could hardly have imagined a case in which a surgical magician would be able repeatedly to effect such an exchange over a number of years in one and the same individual. The case which we now report is possibly unique in this respect; at least we have failed to find a parallel, or even a comparable example, in the literature.

The patient was subjected, during a period of sixteen years, to no fewer than five separate and distinct operations upon his stomach—four gastro-enterostomies and a partial gastrectomy—the last of which he survived for two years more, finally dying of chronic interstitial nephritis and arteriosclerosis. The tendency throughout was for the original ulcer to heal and a fresh ulcer to develop in relation to the new stoma, and even at autopsy two new ulcers were present in the small remaining portion of the stomach. All the operations were carried out in the Leeds General Infirmary, as was the post-mortem.

FIRST HOSPITAL PERIOD.—The patient, when he first came under observation in 1905, was a single man of 36, born of healthy stock and a solderer by trade. He was a hard-working man and a moderate beer-drinker, and he lived in healthy and comfortable surroundings. He had suffered for many years from dyspeptic symptoms, with long intervals of freedom, but was otherwise healthy. A duodenal ulcer was found at operation, and posterior gastro-enterostomy performed (*Fig.* 377, 1).

SECOND HOSPITAL PERIOD.—Nine years later, on June 1, 1914, he was again admitted to hospital. He stated that he had remained well for five years

after operation, but since then he had had attacks of vomiting coming on at intervals of three or four months. During the attacks he vomited, every three

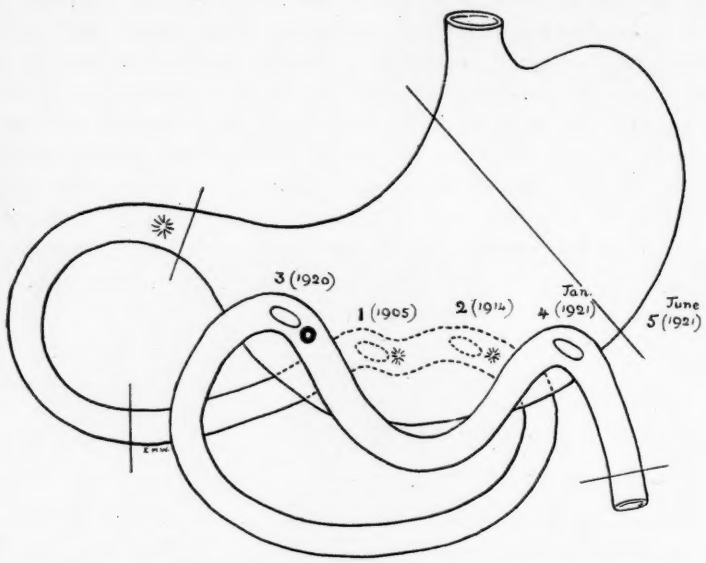

FIG. 377.—Schematic representation of the stomach as it was in June, 1921, showing the various operations performed—four gastro-enterostomies and a partial gastrectomy—with dates. Scars are indicated in the duodenum, and in the efferent limb of the jejunum in relation to both posterior gastrojejunal anastomoses. There is an open ulcer in the efferent limb of the third jejunal loop.

or four days, large quantities of cocoa-like material, amongst which he could often detect relics of food taken two or three days before. Examination showed a much-dilated stomach but no visible peristalsis, and there was no pain. At operation there was a large ulcer in the duodenum and another in the jejunum just below the stoma. The latter was much stenosed, only admitting the tip of the

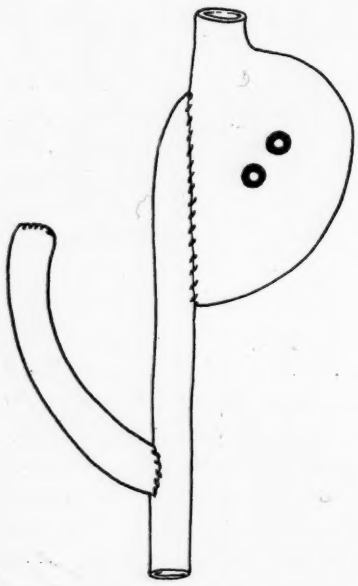

FIG. 378.—Diagram to show the relation of parts after partial gastrectomy had been performed. At autopsy two years later there were two subacute ulcers in the cul-de-sac.

little finger. A second posterior gastro-enterostomy was performed on the cardiac side of the first (*Fig.* 377, 2).

THIRD HOSPITAL PERIOD.—The third admission was in January, 1920. Following the second operation he remained in good health for four years, but in 1918 he began to have pain in the upper abdomen half an hour to one hour after food. This was associated with flatulence, but there was rarely any vomiting. He had lost about as tone in weight. X-ray examination on

Feb. 3, 1920, showed a well-marked filling defect in the middle third of the stomach. There was also much stasis of stomach contents in both the cardiac and pyloric halves of the organ, the opaque meal being still partially present in both after the lapse of six hours. Obviously there was insufficient patency both of the gastro-jejunal stoma and of the pyloric orifice. In addition, the jejunal loop was somewhat dilated, suggesting a kink or other obstruction on its distal side. On Feb. 5, 1920, a third laparotomy was undertaken, and a large indurated jejunal ulcer found close to the *second* gastrojejunal stoma. The afferent limb of the jejunum was much dilated up to the anastomotic site. The jejunal ulcer was much too large, indurated, and adherent to allow of removal, so a third (anterior) gastro-enterostomy was performed (*Fig.* 377, 3). Eighteen days later, high intestinal obstruction developed and the abdominal wound was reopened. The jejunum was found kinked and obstructed at a point four inches beyond the newly-formed stoma. The obstruction was relieved, and the patient thereafter made an uninterrupted recovery, being discharged from hospital a month later.

Fourth Hospital Period.—This time the amelioration of the patient's state was of short duration. On leaving hospital he immediately returned to work and continued thereat for a month, during which time he was able to eat his food without pain or trouble of any kind. Then (May 22, 1920) he had a severe attack of abdominal pain, for which he was admitted to hospital five days later. He was treated by dietetic and medicinal means and discharged on July 2.

Fifth Hospital Period.—He remained well for a month or two, and then began again to have abdominal pain and discomfort, with occasional vomiting, half an hour to one hour after meals. His stomach felt distended and he lost weight. On X-ray examination the stomach was completely empty after six hours, the barium meal having then reached the splenic flexure. At operation on Jan. 27, 1921, a new jejunal ulcer was found in relation to the last (anterior) gastrojejunostomy opening. The old posterior stomas appeared to be largely cicatrized up, and the duodenum also appeared to be impermeable. A second anterior gastro-enterostomy was performed on the cardiac side of the previous one (*Fig.* 377, 4), and the patient was discharged 'relieved' on Feb. 19.

Sixth Hospital Period.—The patient was re-admitted on June 4 of the same year (1921), with more or less continuous pain in the left upper abdomen. It came on after breakfast, persisted throughout the day, and was aggravated by the ingestion of more food. There was no vomiting, the bowels were regular, and the appetite was good. Examination showed a swelling in the left upper quadrant of the abdomen, but no rigidity and very little tenderness. At operation on June 6 a large ulcer was found in the jejunum in relation to the first of the two anterior gastro-enterostomy stomas, presumably the same that had been observed at operation four months before. Partial gastrectomy was performed (*Fig.* 377, 5), and the jejunum anastomosed to the remaining portion of the stomach (*Fig.* 378). The duodenum was implanted into the jejunum at a slightly lower level, the whole of the pyloric portion of the stomach being removed with the attached jejunal loops. The patient made an excellent recovery and was discharged on July 9, 1921. The partial gastrectomy specimen showed an active chronic ulcer in the efferent jejunal

limb of the third (first anterior) gastro-enterostomy. Both the posterior stomas were closed by cicatrization, as was also the first part of the duodenum, but the anterior stomas were patent.

SEVENTH HOSPITAL PERIOD.—On Aug. 14, 1923, two years and one month later, he was re-admitted complaining of increasing weakness, constipation, and flatulence, with attacks of retching and occasional sickness, all of about six months' duration, and failure of vision of two or three weeks' standing. He had remained well for some eighteen months following his last operation, and the subsequent onset of symptoms was insidious. On admission he was much emaciated, there were petechial hæmorrhages all over the body, and the nose bled slowly and continuously. Sometimes he vomited a little fluid mixed with partially-digested food. The respirations were deep and sighing, and he hiccuped continually. Mentally he was dull, answered questions slowly, and took little interest in his surroundings. The pulse, 90, was regular in force and rhythm and obviously of high tension. The apex beat, heaving in character, was visible and palpable over a large area, and the area of cardiac dullness was increased to the left. The urine, sp. gr. 1010, was slightly albuminous and contained a few hyaline and granular casts. There was well-marked neuroretinitis in both eyes, with hæmorrhage into the disc and macula on the left side. The diagnosis was chronic interstitial nephritis with arterio-sclerosis and incipient uræmia. The patient lapsed into a comatose state, and died on Aug. 29, 1923.

POST-MORTEM EXAMINATION.—The *kidneys* were much reduced in size and their capsules stripped with difficulty, leaving a coarsely granular surface. On section, the cortex was much narrowed and badly differentiated from the medulla, while its markings were very irregular. The *abdominal arteries* generally were the seat of well-marked medial arteriosclerosis, and the *heart*, which weighed 16 oz., showed great hypertrophy of the left ventricle. There was a terminal œdema of the *lungs* and early hypostatic consolidation of the left base. In the small remaining portion of the *stomach* there were two oval subacute ulcers, each about half an inch in diameter.

SUMMARY.

A case is reported in which, within sixteen years, four operations of gastro-jejunostomy, two posterior and two anterior, and one of partial gastrectomy, were performed. The original duodenal ulceration and subsequent jejunal ulceration in relation to the two posterior gastrojejunal stomata cicatrized completely in turn, while fresh jejunal ulceration in relation to the third stoma was present at the time of the partial gastrectomy. The patient died of chronic interstitial nephritis two years and one month after the fifth and final operation, and at autopsy two subacute ulcers were found in the remaining portion of stomach.

The case illustrates in a remarkable fashion both the tendency to recurrent ulceration met with in certain cases of duodenal ulcer, and the healing power of nature even in the case of very large and very chronic ulcers. Unfortunately no gastric analyses were carried out, but, judging by other cases of jejunal ulceration, a persistent hyperchlorhydria may reasonably be assumed to have been present.

A CASE OF DOUBLE URETER, WITH CALCULI IN EACH CHANNEL.

By R. ST. LEGER BROCKMAN,

ASSISTANT SURGEON TO THE ROYAL INFIRMARY, SHEFFIELD.

F. H., male, age 22, four months previously was seized with pain in the left loin which radiated round to the lower iliac region in front. Immediately afterwards blood was noticed in the urine for the first time. Two weeks later the attacks of pain ceased, but the hæmaturia persisted and gradually increased in amount. There was never any dysuria or frequency.

The X-ray film (*Fig.* 379) showed a collection of calculi in the lower portion of the left ureter, with probable calcareous glands on the right side. The outline of the left kidney was considerably enlarged. At this period no suggestion was made of any possibility of a double ureter. A cystoscopic examination showed no abnormal features in the wall of the urinary bladder. Indigo-carmine was freely excreted from the right ureter in seven minutes, but no secretion of any kind was seen on the left side, where only one ureteric orifice was observed in the normal position. A diagnosis was made of hydronephrosis with calculi in the lower end of the left ureter.

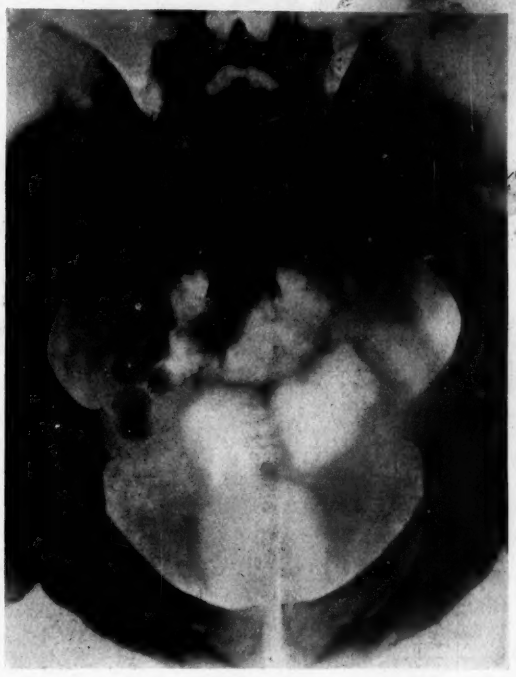

FIG. 379.—Skiagram indicating two lines of stones in the double ureter.

FIG. 380.—To show the stones in the position they formerly occupied in the ureters.

At operation, through a lumbar incision, a large hydronephrotic kidney was found with double ureters extending from the pelvis of the kidney almost down to the bladder. These were both dilated to such an extent that the

lumen of each admitted the tip of the index finger with ease. Four calculi were found in one and three in the other. The kidney, with as much of the ureters as possible, was removed, the stones being previously milked into the upper portion of the ureters.

On examining the X-ray film again after the operation it was easy to see that the condition of the double ureters, with the stones which each contained, was there clearly demonstrated. *Fig.* 380 shows the specimen after removal, together with the calculi in line with their respective ureteric beds.

The patient made an uninterrupted recovery.

ABDOMINAL TORSION OF THE OMENTUM.

By P. STANLEY FOSTER,

HON. SURGEON TO CHRISTCHURCH HOSPITAL, NEW ZEALAND.

The publication of an article on abdominal torsion of the omentum by Ernest Cowell in the British Journal of Surgery of April, 1925, leads me to report notes of the following case.

A. T. J., male, age 45 years, a farm labourer, was admitted to Christchurch Hospital as an urgent case on March 23, 1924. He had been seized with sudden acute pain in the lower abdomen the previous night; the pain was continuous and severe. He vomited once on the morning of admission. He had had no previous attacks, and had always been strong and healthy; he said he had a right inguinal hernia.

On Examination.—The patient's temperature was 98·2°, the pulse 72. His tongue was furred and his breath foul. He was in great pain. The abdomen moved only slightly with respiration; there was marked rigidity of both recti, particularly on the right side in the lower quadrant, and tenderness was complained of only in this quadrant. Rectal examination showed marked generalized tenderness. His hernia sites appeared normal; heart and lungs were normal. He obviously had an acute surgical abdomen, and acute appendicitis was diagnosed.

Operation.—Immediate operation was performed, the abdomen being opened through the outer edge of the right rectus. Free blood-stained fluid escaped on opening the peritoneum, and some very dark and engorged omentum presented. This was delivered from the wound and proved to be the whole omentum twisted through five turns. The mass was removed easily, there being no adhesion or attachment whatever; it weighed exactly one pound. The appendix was found to be swollen and inflamed and was removed; on investigation it showed acute catarrhal inflammation. The patient made a good recovery and went home on the twelfth day.

Many cases of torsion of the omentum that are recorded show some connection of the omentum to a hernial sac, and this is regarded as being the cause. In this case I attributed the condition to irritation in the appendix. The hernia which the patient alleged was never observed, and there was no connection of the omentum with his hernial region.

TORSION OF A PORTION OF THE OMENTUM.

By G. A. REID,

SURGEON TO THE ROYAL VICTORIA AND WEST HANTS HOSPITAL, BOURNEMOUTH.

In the 'Epitome of Current Medical Literature' in the *British Medical Journal* of April 30, 1927, attention is drawn to a paper by A. Pollidori[1] on torsion of the omentum. Three varieties are described by Lejars: (1) Torsion combined with an irreducible hernia; (2) Torsion with an empty hernial sac; and (3) Torsion unaccompanied by a hernia. As only sixteen cases of the last are said to be on record the following case may be of interest.

S. G., female, age 65 years, suffered for about a fortnight from an aching discomfort in the lower abdomen which was relieved by lying down, but which did not prevent her doing her work as a cook. About 2 p.m. on April 16, 1927, she vomited a dose of castor oil taken an hour previously, and was seized with severe lancinating pains in the upper abdomen. These, associated with frequent retching, persisted until the patient was seen about 6 p.m. She was then lying on her back with her legs drawn up; her expression was strained and anxious; she was moaning continuously and begged not to be moved, as any movement made the abdominal pain worse.

On Examination.—The temperature was 98° and the pulse 80. The whole abdomen was rigid and very tender on pressure above and to the right of the umbilicus. Pressure here caused pain shooting to the left side.

Operation.—Operation was performed in hospital two hours later. On opening the abdomen by a vertical incision through the middle of the right rectus above the umbilicus, there was a free flow of blood-stained clear fluid, and a piece of omentum about 3 in. long by 1 in. thick, adherent by a small tip to the lesser curvature of the stomach about 2 in. from the pylorus, black and strangulated by torsion on itself, was discovered and removed.

No other abdominal lesion was found. Convalescence was uneventful and there was complete freedom from all the old abdominal discomforts.

REFERENCE.

[1] *Arch. ital. di Chir.*, 1927, March.

A CONGENITAL TUMOUR OF THE NECK.

By D. W. DANIELS,

SURGEON TO THE MANSFIELD HOSPITAL.

A male child was born on May 30, 1927, having a large swelling on the left side of the neck. This extended from the ramus of the jaw above to just above the clavicle below. It varied in consistency, in places being hard and in others fluctuating. It did not extend beyond the middle line. As the child grew the tumour kept pace, and, projecting under the jaw, interfered with the feeding. It was decided that removal should be undertaken.

Operation.—On July 7 Dr. S. Littlewood anæsthetized the child, and with the assistance of Dr. G. T. Elder the growth was removed. The tumour was in the left lobe of the thyroid gland—in fact it made up the whole of that lobe, so far as could be seen. There may have been some normal thyroid tissue behind, but it was not apparent. Enucleation was possible to a great extent except where the superior and middle thyroid arteries ran into the growth with a certain amount of tissue. There was very little hæmorrhage, but at this stage the child was in a poor condition, so the operation was concluded by clamping and ligaturing the vessels at the posterior border.

The child picked up rapidly after the operation, but showed chest signs twenty-four hours later and died on July 9.

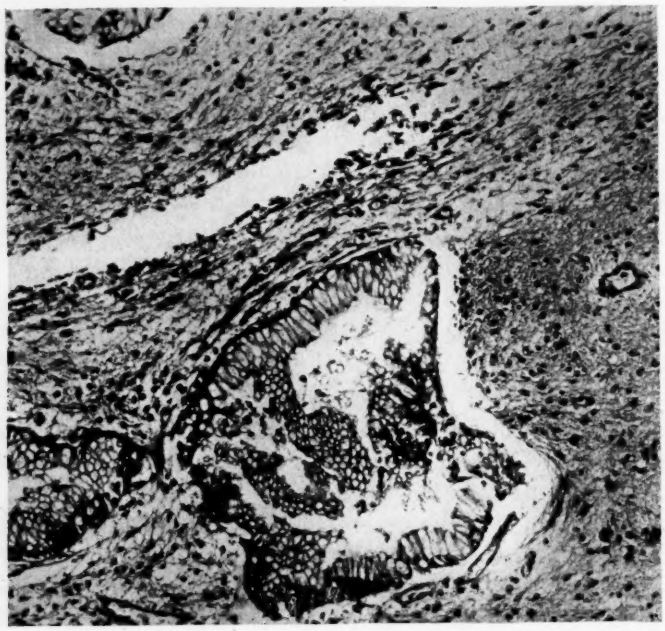

Fig. 381.—Section of a part of the tumour. (× 110.)

Pathological Report.—The tumour was about four inches long and was shaped like a potato. It contained some cysts. A specimen was submitted to the Clinical Research Association, and Dr. E. W. Bowell, who took the accompanying microphotograph (*Fig.* 381) reported as follows :—

"The tissue does not resemble normal thyroid, even in its embryonic form. It consists of a fine reticulum composed of relatively large cells with branching cytoplasm ; a few leucocytes are seen wandering in its meshes. This structure occurs in regular masses which show some appearance of twisting as though they belonged to a more complex organ. Blood-vessels are scantily represented except in the central parts of the twisted structure, and in the loosely made capsule of fibrous tissue which encloses it. Here and there are seen irregularly shaped spaces lined with a special epithelium, which in favourable cases shows large round nuclei like those of the typical thyroid gland, lying at the base of an elongated clear cytoplasm resembling that of a

mucinous epithelium. In some places the epithelium appears to be ciliated. The tissue is abnormal, and may be called a teratoma. It resembles the primitive thymus in several particulars, and may be a displaced portion of that organ. There is no evidence, in the tissue itself, that it is malignant."

Referring to the photograph Dr. Bowell says: "This shows quite clearly that much cytoreticular tissue is brain substance, and I have very little doubt that the structure in the middle is an attempt at gastric glands."

This case has been put on record because of its interest and unusual features.

A CASE OF PEDUNCULATED LIPOMA OF THE UPPER ARM.

By B. T. ROSE,

ASSISTANT SURGEON, GENERAL HOSPITAL, BIRMINGHAM.

Mrs. A. M. was brought to hospital for the removal of a large tumour of the upper arm. The growth had been present for twenty-five years, slowly enlarging to its present size. It consisted of a lipoma which in part seemed to be undergoing mucoid degeneration. The mass was attached by a pedicle to the inner and upper part of the upper arm (*Fig.* 382), and in this some vessels of considerable size could be felt.

Fig. 382.—Pedunculated lipoma of the upper arm.

The patient suffered no pain, but was greatly inconvenienced by the weight of the mass, which she was obliged to carry suspended by a sling from the opposite shoulder. A year previously the mass had been ulcerated as the result of friction in the sling, but this had healed with simple remedies applied at home.

Removal was advised and performed under local anæsthesia. The pedicle contained several large veins and one artery of considerable size. Healing by first intention followed. Examination of the tumour after removal showed that it consisted of a lipoma, with considerable œdema of the connective tissue. It weighed in the fresh state 8½ lb.

REVIEWS AND NOTICES OF BOOKS.

An X-ray Atlas of the Normal and Abnormal Structures of the Body. By ARCHIBALD MCKENDRICK, F.R.C.S.Ed., D.P.H., F.R.S.E., Hon. Consultant (late Surgeon in charge), X-ray Department of the Royal Infirmary, Edinburgh, Examiner in the Royal College of Surgeons, Edinburgh; and CHARLES R. WHITTAKER, F.R.C.S.Ed., F.R.S.E., Assistant Lecturer in Anatomy, Surgeon's Hall, Edinburgh, Examiner, Royal College of Surgeons, Edinburgh. Second edition, revised and enlarged. Demy 4to. Pp. 256 + xvi. 1927. Edinburgh: E. & S. Livingstone. 30s. net.

THE first edition of this book was published in 1925; the call for a second edition so soon after its issue is eloquent testimony to the value of the work. The opportunity has been taken to revise the text thoroughly and to insert many additional radiograms, among which may be mentioned a series of lipiodol injections of the bronchi by Dr. John Guy. The contents of the book reflect credit upon the skilful and painstaking efforts of the authors, and they have succeeded in placing in the hands of a large circle of readers a book of the utmost value as a reference volume, which must find its way into the libraries of all interested in the subject.

The quality of the radiographic half-tones is very high. Interpretation of these pictures is made easy by a lucid text, illustrated, where necessary, by good line drawings. The latter are marked with great care, so that the reader may rely upon careful anatomical accuracy to guide him in interpretation. A good technique is given for the radiography of particular joints; the advantage of this is obvious, and adherence to its details should lead to a standardization of radiography for the whole of the body, an important point when the work of radiologists has to be compared. The usual focus point is given for the majority of the joints as directly over the centre of the joint. This is clear, but it is not always easy to determine which is the centre of the joint; an obvious improvement in a subsequent edition would be to give for each joint one or more well-known landmarks, from which the centre of the joint could readily be found. Departures from the normal focus point for special regions are well defined.

A useful feature of the technique is illustrated in the directions for the hip-joint; in all ten radiograms are shown, taken from points in relation to the normal focus point; each demonstrates the value of the method elaborated by the authors, and a great deal of information of value is elucidated by a study of the radiograms.

The same thoroughness is noted throughout the work. It is a pleasure to comment on the very important points to which the authors draw attention. When a teacher of anatomy and a skilled radiologist collaborate in a work of this kind it is natural to look for accuracy in the descriptions of the anatomical details of the bones and joints. The reader will not be disappointed in this respect; the book is full of the most useful and essential information, and in no part is this more noticeable than in that dealing with the epiphyses. The details given are of great value, which is enhanced by the line drawings which accompany each radiogram.

The first thirty pages of the book are devoted to the study of the normal. Well over two hundred of the pages are given over to the consideration of the diseases of the limbs, the head and neck, the abdomen and spine, and to an appendix. In these pages many illustrations of value are selected, and a comprehensive survey of the more common conditions is given.

The authors are to be congratulated on the success which has attended their efforts, and it is easy to predict that the success of this edition will be as great as the first. A call for a third edition will not be long delayed.

Atlas de Radiographie osseuse. Part I: Squelette normal. By G. HARET, A. DARIAUX, Electro-radiologistes des Hôpitaux de Paris; and JEAN QUÉNU, Professeur agrégé à la Faculté de Médecine, Chirurgien des Hôpitaux de Paris; with the collaboration of H. P. CHÂTELLIER. Preface by Professor PIERRE DUVAL. Large 8vo. Pp. 129 (123 plates). 1927. Paris: Masson et Cie. Fr. 160.

MM. Haret, Dariaux, and Jean Quénu present an atlas of bone radiology, which will consist of two parts. The first, which is under review, deals with the radiographic appearance of the normal skeleton. The second will deal with the deviations from the normal met with in the osseous system. The publication of such a work was, in the opinion of the authors, necessary to fill a gap in the sequence of books of reference on radiography, and to those who deal intimately with radiographic interpretations it is at once apparent how thoroughly they have entered into the work of producing such an atlas. An appreciation of the thoroughness of the work is evident on inspection of the large number of illustrations, each of which is duplicated by a key picture on which the anatomical features have been marked in ink; the complete picture gives a very valuable aid to interpretation. As a help to diagnosis the work must become indispensable to radiologists, clinicians, and students. It could only have been produced by the collaboration of several workers, each familiar with the anatomical descriptions of the bones, and the radiographic appearances of these when viewed in the radiogram.

As a work of reference the book must find its way into the hands of radiologists, clinicians, and medical students; for the latter it will be well to include it in the list of books read in the preliminary anatomical studies. A new and more useful conception of anatomical structure of bone will be obtained, and one which will, in later years, be of immense service to the student.

For the radiographic study of the normal skeleton the writers have employed a method which is not new; it has been used by numerous radiologists periodically; the present work, however, is the first in which the method has been so systematically applied in such a comprehensive manner. They have succeeded in convincing all workers of the value of the system. Instead of explaining the radiogram by a simple drawing, they have indicated upon a second radiogram, printed in the clearest tone, all the details which should be read upon the first. This proceeding explains with clearness the superimposition of shadows of structures which in the ordinary way are difficult of interpretation. The method, when applied to difficult cases, will speedily help in the clearing up of obscure points.

It is undeniable that if the student studies these illustrations closely, and uses the anatomical details given with each picture, he will soon place his knowledge upon a sure foundation of anatomical and radiological data. All who are interested in radiographic interpretation are recommended to make a complete study of the many high-grade illustrations in this admirable book. The general practitioner, unaccustomed to the reading of X-ray pictures, will do well to turn to the pages of this book when confronted with a skiagram of an obscure bone injury in one of his patients.

The authors are to be congratulated on the production of a work which will find a place in all reference libraries, and which should be prized by practical radiologists as a most useful guide in the interpretation of many obscure points in diagnosis.

Röntgendiagnostik in der Chirurgie. By Dr. HERMANN MEYER, Professor of Surgery in the University of Göttingen. Royal 8vo. Pp. 610, with 655 illustrations. 1927. Berlin: Julius Springer. M. 48; bound, M. 50.70.

THE title of this book adequately expresses its scope. It is a comprehensive study, treated with characteristic German thoroughness, which convinces one of the extent to which X rays, by suitable technique, can aid the surgeon in the diagnosis and treatment of the increasing number of conditions with which he is called upon to deal. Merely to glance through the 655 excellent illustrations, which are an outstanding feature of the volume, is time well spent.

The arrangement of the book is somewhat original, and designed to convince

the reader of the exact scope of X rays in diagnosis without forgetting their limitations. Two-thirds of the chapters are allotted to bone conditions, and the remaining third to the latest contrast-methods, natural or artificial, of examining the soft parts—namely, by opaque or gaseous injections as employed in opaque meals and enemata, pneumothorax, cholecystography, pyelography, myelography, ventriculography, etc. There is a good section on those chest conditions which are coming more and more within the scope of surgical rather than purely medical treatment.

The author's treatment of the physiology and pathology of bone and joints is excellently arranged under pathological headings, well illustrated, and very comprehensive, and the diagrams which often accompany or supplement the skiagrams are most helpful. The book has a good index and an extensive bibliography.

Die Chirurgie: A System of Surgery. Edited by Professors KIRSCHNER and NORDMANN. Imperial 8vo. Berlin: Urban and Schwarzenberg.

FASCICULUS 16, Vol. V. Pp. 395, with 102 illustrations, partly in colour, and 4 coloured plates. M. 24.

THIS section deals with the surgery of the intestines. Professor Kleinschmidt and Professor Hohlbaum write the greater portion, which is concerned with the diseases of the intestine and their treatment. Their article is introduced by chapters dealing with the history, anatomy, and physiology of the intestinal canal. After further chapters on the diagnosis and general surgical treatment, the formal operations of anastomosis and resection are carefully described and beautifully illustrated. There follows an important section on congenital malformations of the intestines, and among these Hirschsprung's is particularly well described, and we only regret that the part devoted to treatment is somewhat abbreviated.

In discussing intestinal stasis the author of the article is content to give a list of no fewer than twelve operative procedures which have been devised for the relief of this condition without giving any very clear indication as to the choice of one or the other. Rare and unusual forms of disease, such as multiple tuberculous stricture, actinomycosis, and syphilis, are fully described. In dealing with the new growths of the intestine a comparatively long section is devoted to the carcinoid and other rare forms of growth. A very full account is given of intestinal obstruction, with a remarkably complete number of different types of strangulation by bands and volvuli. The last chapter in this section is by Professor Payr and deals with visceroptosis. Here again it is only the subject of treatment that is not very fully discussed, although various suggestions which have been made for the fixation of displaced organs are mentioned. Those relating to the fixation of the stomach are given the greatest importance, whereas colopexy is barely mentioned.

FASCICULUS 17, Vol. II. Pp. 392, with 212 illustrations in the text and 2 coloured plates. M. 20.

THIS portion of the second volume deals with the general account of new growths (Professor Coenen) and parasitic diseases (Professor Hosemann). The greater part of this description is clearly written and well illustrated, being on usually accepted lines. An interesting point is the inclusion of giant-celled sarcoma with osteitis fibrosa. The classification is on rather unusual lines. In the first large group are included connective-tissue tumours, both innocent and malignant; in the second, tumours of the pigment-forming tissues, which practically only contains the melanoma; the third is the tumour of the muscle tissue; the fourth the tumours of the nervous system (and here we may remark that the subdivisions of the different forms of gliomata and neuromata is very bewildering); the fifth group includes the tumours arising from hæmatoblasts—that is, lymphoma, myeloma, chloroma, etc.; the sixth group are the fibro-epithelial tumours, including the papillomata, polypi, adenomata, and basal-celled epitheliomata; the seventh contains the epithelial tumours—that is, the carcinomata and chordomata; the eighth group includes the teratomata; whilst a last group is devoted to the mixed-celled tumours of the kidneys and urinary

bladder. Apart from this unusual classification, the section on tumours is simple, well written, and illustrated profusely with microscopical sections, but not so generously with clinical pictures. No doubt the latter omission is made up for by the fact that all the important tumour groups are separately described in their appropriate sections of the work. The chapter on parasitic diseases deals chiefly with the oxyuris, ascaris, tænia, and echinococcus.

FASCICULUS 18, Vol. IV. Pp. 263, with 136 illustrations in the text and 11 coloured plates. M. 21.

THIS section is concerned with the lungs, air-passages, pleura, and diaphragm. Surgery of the lungs is described by Professor Meyer. It gives a short historical introduction and some very good anatomical sketches showing the relations of the lungs and mediastina. The problems of pneumothorax are fully discussed, and the various types of apparatus for establishing differential pressure fully described. The next chapter, by Dr. Frenzel, deals with foreign bodies in the air-passages. It gives a well-illustrated account of the different types of impacted foreign body, and also of the ingenious apparatus for their removal. The technique for the use of Brüning's endoscope is very fully described. The section on the pleura is by Professor Landois, and it includes a description of various operations for the exposure of the lung, removal of foreign bodies, as well as the more usual operations for the relief of empyema. The last section, on the diaphragm and the phrenic nerve, is also by Professor Landois. It contains some very clear coloured illustrations of the course and relations of the phrenic nerve, with a good discussion on the indications for phrenicotomy. A consideration of congenital and acquired defects of the diaphragm includes an account of diaphragmatic herniæ.

FASCICULUS 19, Vol. II. Pp. 209, with 208 illustrations. M. 14.

THIS section deals with the preparation for, the dressing, and the after-treatment, of surgical operations, and is by Professor Nordmann. It does not call for any special comment; it contains a large number of well-drawn diagrams illustrating the ordinary methods of bandaging, a few simple splints, plaster-of-Paris appliances, and the apparatus for the traction treatment of fractures. In the latter, exception may be taken to the complicated appliances used for transfixion. Also it is remarkable that none of the types of Thomas's splint are recognized. This chapter is, however, intended to deal only with general principles, and the details of the special treatment of fractures and of abdominal wounds are to be found in other parts of the work. The latter half of this fasciculus is by Dr. Tiesenhausen and deals with plastic operations on the skin. The general description of skin-grafting is clear and well illustrated. The special operations for restoration of parts of the face seem to us to be a little redundant, considering that this subject is dealt with in Volume IV under surgery of the face and the nose.

The Meningiomas arising from the Olfactory Groove, and their Removal by the aid of Electro-surgery. By HARVEY CUSHING, C.B., D.S.M., A.M., M.D.. Harv. LL.D. Camb. and Glas. Royal 8vo. Pp. 55, profusely illustrated. 1927. Glasgow: Jackson, Wylie & Co. 2s. 6d. net.

THIS pamphlet embodies Professor Harvey Cushing's Macewen Memorial Lecture delivered on June 22, 1927. The first fourteen pages are historical, and are written in the lecturer's own delightful style. In them he justly emphasizes Macewen's rightful place as one of the foremost pioneers in the surgery of the nervous system. The remaining forty pages are devoted to meningeal tumours, and are largely taken up with a detailed account of a case of 'olfactory groove meningioma', the removal of which occupied seven hours! The matter of greatest surgical interest lies in the fact that a method of electro-coagulation was made use of, which rendered the loss of blood during this lengthy period comparatively small, though not so small as to do away with the necessity for blood transfusion at the completion of the operation. The electro-physical principles involved are, he says, highly technical,

and hardly as yet in more than an experimental stage; yet it "permits us to-day to remove certain brain tumours from situations and under circumstances which a year ago—indeed, six months ago—I would not have thought possible". It is curious that Professor Cushing, who has recently distinguished some thirteen varieties of glioma, should coin the somewhat cacophonic, non-committal term 'meningioma', to avoid the far simpler histological classification of the endotheliomata which arise in the cerebral membranes.

Exposure of the Long Bones and other Surgical Methods. By ARNOLD K. HENRY, M.B., B.Ch. Univ. Dublin, F.R.C.S.I., Director of the Surgical Unit, Kasr el Aini Hospital, Cairo. With a Foreword by Sir W. I. de C. WHEELER, F.R.C.S.I., Visiting Surgeon, Ministry of Pensions Hospital, Blackrock, etc. Medium 8vo. Pp. 80 + xii, illustrated. 1927. Bristol: John Wright & Sons Ltd. 10s. 6d. net.

A MAJORITY of the papers in this volume have appeared in the BRITISH JOURNAL OF SURGERY, but those who have made use of Professor Henry's incisions for exposure of the long bones will none the less be glad to have them collected together in more accessible form. The other papers deal with structures the exposure of which is much less common, ranging from the left cervicodorsal ganglion of the sympathetic to the nasal route to the pituitary, and are certainly worthy of perusal by any surgeon contemplating an attack on these organs.

Diagnostic chirurgical. By W. M. STERN, Ancien Interne des Hôpitaux de Paris, Membre Correspondant de la Société de Chirurgie. Eighth edition. Medium 8vo. Pp. 1238, with 675 illustrations, some in colour. 1927. Paris: Gaston Doin et Cie. Paper covers. Fr. 130.

IN this, its eighth, edition, *Diagnostic chirurgical* has been entirely recast. The plan of the book is that on each region of the body there is a chapter showing how one ought to examine that region: then several chapters on differential diagnosis. There are no unnecessary details; clarity and precision have been the objects throughout. Supplementary methods of examination, such as laboratory and radiological examinations, are added when it is necessary to clear up a doubtful diagnosis. In addition there is a very detailed alphabetical index.

This book is intended chiefly as a reference book for those practitioners who have not the time or inclination to read a large text-book.

Physical Signs in Clinical Surgery. By HAMILTON BAILEY, F.R.C.S., Surgeon, Dudley Road Hospital, Birmingham, etc. Medium 8vo, Pp. 217, with 261 illustrations, some in colour. 1927. Bristol: John Wright & Sons Ltd. 21s. net.

THIS is an admirable book, not too big, which consists of a series of demonstrations of the physical signs of clinical surgery. Physical methods of examination must always remain the main channels by which the diagnosis is made in medicine and surgery; too much attention cannot be given by students to learn these methods in the early stages of their life's work. We can recommend the book to all students. It is perhaps to be regretted that the price is 21s., which may prevent many students from buying it. It is very well illustrated, almost too profusely, and it might be possible to reduce the price by reducing the number of pictures, some of which seem unnecessary.

Minor Surgery. By ARTHUR E. HERTZLER, M.D., F.A.C.S., Chief Surgeon, Halstead Hospital; and VICTOR E. CHESKY, A.B., M.D., F.A.C.S., Chief Resident Surgeon, Halstead Hospital. Medium 8vo. Pp. 568, with 438 illustrations. 1927. London: Henry Kimpton. 42s. net.

IT is rather difficult to reconcile this book of 568 pages, price 42s. net, with its title of *Minor Surgery*, and it is equally difficult on reading the text. In the preface it is stated that it has been prepared with the idea of helping the dispensary

student with what he sees in the out-patient clinic. No reference to pathology is made because the book is intended to be entirely a practical one. It does not appear to be any great improvement on the many books on minor surgery which already exist.

Le Cancer du Nez, des Fosses nasales, des Cavités accessoires du Naso-pharynx. By GEORGES PORTMANN, Professeur de Clinique oto-rhino-laryngologique à la Faculté de Médecine de Bordeaux ; and HENRI RETROUVEY, Oto-rhino-laryngologiste des Hôpitaux de Bordeaux. 8vo. Pp. 980, with 248 illustrations. 1927. Paris: Gaston Doin et Cie. Fr. 150.

THIS is one of a series of works on regional malignant disease, and presents an extremely detailed and up-to-date review of the subject. The book is divided into three distinct sections: cancer of the nose, the nasal passages and accessory sinuses, and the nasopharynx, respectively. In each section the pathology, symptomatology, differential diagnosis, and treatment are dealt with in great detail. Thus, under treatment, in addition to the description of operative methods, the use of diathermy, radiotherapy, etc., is fully described. An important feature is the presentation of results of the various methods of treatment under review. The work is a large one, and, since there is an entire absence of irrelevant matter, it will be realized that the subject has been brought fully up to date. Illustrations are numerous and excellently produced, covering the general pathology, histology, anatomy, and operative detail. A full bibliography is given. While the great detail prevents its being pleasant reading for the odd half-hour, we can cordially recommend it as a most valuable book of reference to the rhinologist and general surgeon. The general standard of printing, paper, and illustration is so high that it deserves a better clothing than the paper cover so loved by the continental publisher.

La Pratique chirurgicale illustrée. By VICTOR PAUCHET, Ancien Interne, Lauréat des Hôpitaux de Paris. Fasc. XI. Royal 8vo. Pp. 269, with 275 illustrations drawn from nature by S. Dupret. 1927. Paris: Gaston Doin et Cie. Fr. 55.

IN this volume Victor Pauchet has contributed articles on penetrating ulcers of the stomach and duodenum, cæcostomy for obstruction, carcinoma of the hepatic flexure, strangulated femoral hernia, diverticula of the bladder, and splenectomy. These articles maintain the high standard reached in previous volumes, and the illustrations of Monsieur S. Dupret more than suffice to explain the text. Georges Liebault writes on antral suppuration, L. Bérard on gastrostomy for carcinoma of the œsophagus, E. Villard on cholecysto-gastrostomy for obstruction of the common duct. Pierre Mornand writes on the operative treatment, and Auguste Bécart on the injection treatment of varicose veins, and the latter also contributes an article on blood transfusion. M. Hautefort describes a modification of Chopart's operation, the essential feature of which is to utilize the extensor tendons to overcome the heel-tilting action of the tendo Achillis. This is accomplished by drilling a hole through the head of the astragalus to pass the tendons through.

This volume, like its predecessors, will repay perusal by operating surgeons, who will find many useful hints, some ingenious methods, splendid illustrations, and but little to criticize.

Guy's Hospital Reports. Edited by ARTHUR F. HURST, M.D., Vol. LXXVII (Vol. VII, Fourth Series), Nos. 3 and 4, July and October, 1927. Medium 8vo. Pp. 253–502, illustrated. 1927. London: Lancet Ltd. Double number 25s. net.

THIS volume of *Guy's Hospital Reports* is the Bright Centenary number, and contains a number of articles which are interesting to the historian and the clinician. One of these articles—"Surgical Treatment of Chronic Bright's Disease: Decapsulation of the Kidneys", by John Fawcett, Consulting Physician to the Hospital—is of great interest to surgeons. Dr. Fawcett gives a résumé of the surgical treatment of chronic parenchymatous nephritis; he says that it is astonishing, but a fact, that surgery is of considerable value in a carefully selected case. The group

most favourable, according to him, is that in which, despite prolonged treatment, there is persistent and considerable œdema accompanied with a large quantity of albumin and casts—the group commonly known under the title of 'chronic parenchymatous' or 'tubal' nephritis.

St. Bartholomew's Hospital Reports. Edited by W. McAdam Eccles, Sir Thomas Horder, Bart., K.C.V.O., Sir Bernard Spilsbury, W. Langdon Brown, W. Girling Ball, and Geoffrey Evans. Vol. LX. Demy 8vo. Pp. 203 + xxviii. 1927. London: John Murray. 21s. net.

The present volume is chiefly devoted to radiation. The article by Dr. Levitt on deep X-ray therapy, and that by Dr. Hopwood on the physical aspect of radium, are followed by a chapter by Dr. Canti on the effect of irradiation on tissues which is the basis of his well-known film. Geoffrey Keynes' brief statement as to what has been done in the radium treatment of carcinoma of the breast does not enable us to draw any practical conclusions; but Dr. Donaldson's article on the radium treatment of carcinoma of the cervix, though dealing with a relatively small number of patients, does at least suggest that this line of treatment is worthy of more extended application. Mr. J. P. Ross contributes a most helpful and well-balanced chapter on cholecystography, from which it is clear that this method of diagnosis is not of very wide application or of great clinical value.

Au Seuil de la Chirurgerie. By Emile Forgue, Professeur de Chirurgie de Clinique Chirurgicale à l'Université de Montpellier, etc. Medium 8vo. Pp. 226. 1927. Paris: Libraire d'Octave Doin. Fr. 18.

Professor Emile Forgue, of Montpellier, has done well to publish this little volume of essays and addresses upon subjects which are not dealt with in the ordinary text-books of surgery and which are yet of importance to every student who wishes to practise his art as a profession and not as a business. Professor Forgue deals with the subjects of "Empirics and Surgeons", "The Relations of Medicine and Surgery", "On the Sanctity of Life", "On the Moral Law as it applies to Surgery", "On the Responsibility of the Surgeon to his Patients", and on "Euthanasia". In these essays he outlines the problems which confront French surgeons, more especially those who practise in the provinces, and we learn incidentally how greatly they differ from those which have to be solved by his English brother. The French peasant still has an innate horror of a hospital and an ill-concealed opposition to all surgical procedure. This feeling has been lived down in England, and every class is only too eager to go into hospital when any question of a surgical operation arises; in France the influence of the family is against such admission even in the most serious cases.

Professor Forgue is well read both in English and German, and on several occasions he quotes with approbation the opinions of Sir James Paget. Where all is good, perhaps the least good is the address on euthanasia, which is treated of in a philosophical rather than a practical manner. As with many French books, there is only a short table of contents and an entire absence of index.

The Injection Treatment of Varicose Veins. By A. H. Douthwaite, M.D., M.R.C.P.(Lond.). Crown 8vo. Pp. 39 + viii. 1927. London: H. K. Lewis & Co. Ltd. Limp covers. 3s. net.

This little book aims at introducing to the general practitioner the method of treating varicose veins by the injection of sclerosing fluids. The author does not claim originality, but follows Génévrier in using a solution of quinine and urethane, which he has found to give satisfactory results. We feel that the book would be more likely to achieve its purpose were fuller details given as to the number of injections normally required and the average length of the treatment. Some details of the author's cases would be valuable as forming a basis for prognosis. There is an adequate index and a small bibliography.